

The diversity of Orthoptera in the northwestern parts of Mount Kinabalu, Sabah, Malaysia

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Abstract

The Orthoptera from Borneo require further research since some areas have never been studied, including parts of Mount Kinabalu in Ranau, Sabah. A five-day survey at Marai Parai and Nunuk in October 2023 revealed 32 species of Orthoptera from nine families. There are at least nine new species records for the Mount Kinabalu region and four new species records for the state of Sabah. Twenty-one out of the 32 species collected are singletons, indicating that many species on Mount Kinabalu are rare and of low abundance or collected during the wrong season. Hence, an annotated and illustrated checklist of the Orthoptera of this region is presented with notes on their taxonomy and, where data are available, on their natural history. With extended sampling, it is expected that more species will be discovered than in this preliminary checklist.

Keywords

Checklist, Marai Parai, new record, Southeast Asia, taxonomy

Introduction

Mount Kinabalu is the highest mountain in Borneo, and the habitats in and around this mountain are mega-rich in biodiversity (Nor 2001, Sabah Parks 2022, UNESCO World Heritage Convention 2022). As of May 2024, about 89 species of Orthoptera have been documented to occur at Mount Kinabalu (Cigliano et al. 2024). New species and genera have been recently discovered, including *Borneratura atromacula* Gorochoy, 2022; *Depressacca kinabalu* Ingrisch, 2020; *Subtilodecma bilobata* Gorochoy, 2022; and *Subtilodecma unilobata* Gorochoy, 2022 (Ingrisch 2020, Gorochoy 2022), highlighting that we do not necessarily have a good understanding of this famous mountain's orthopteran diversity due to the mountain's vast terrain.

Marai Parai (1652 m.a.s.l.), located on the western slope, is one of the lesser-known areas of Mount Kinabalu (Fig. 1). It is named after the Dusun people's word for the graminoid vegetation

Tetraria pilisepala (Cyperaceae) (Beaman and Beaman 1998), which flourishes in the area. Marai Parai is an ultramafic plateau at the northwest of Mount Kinabalu, Sabah (Fig. 2A) that houses endemic vegetation that includes few species of pitcher plants (Van der Ent et al. 2015) (Fig. 2B). The climate is cold, and the soils are nutrient-poor and waterlogged due to high humidity and frequent rainfall. Kiau Nuluh (880 m.a.s.l.), a village bordering Kinabalu Park in the district of Kota Belud, serves as the starting point of the route to Marai Parai. Surrounding the village is a forest reserve referred to locally as the community forest area of Kiau Nuluh; this extends from the village up to the border of Kinabalu Park, where Nunuk camp (1215 m.a.s.l.) is situated (Fig. 2C, D) (Cooke and Hussin 2014). No published records of Orthoptera from Marai Parai exist (Cigliano et al. 2024), although expeditions have been conducted there as early as 1858 (Gibbs 1914, Anfraix 2005, Barkman et al. 2016, Cross et al. 2022).

In 2023, the first concerted effort to sample orthopterans from Marai Parai was conducted as part of the Marai Parai—West Gurkha Hut Kota Belud Scientific Expedition. As a result, we present here the first annotated and illustrated checklist of Orthoptera from Marai Parai and Nunuk camp. Notes on the taxonomy and natural history of each species are provided whenever possible. While this checklist is likely preliminary, it offers a foundation for future work on the taxonomy of Orthoptera from Mount Kinabalu, Sabah and Southeast Asia.

Material and methods

Sampling.—The first author (AAM) conducted surveys at Marai Parai camp (6.081897°N, 116.520449°E) and Nunuk camp (6.071725°N, 116.512458°E) from 13 October to 17 October 2023. AAM performed opportunistic collecting during the daytime (0830 to 1500 hours) and nighttime (1900 to 2200 hours). Specimens were photographed using an Olympus OM-D E-M5 Mark II interchangeable lens camera with an M.Zuiko Digital ED 60 mm F2.8 macro lens attached.

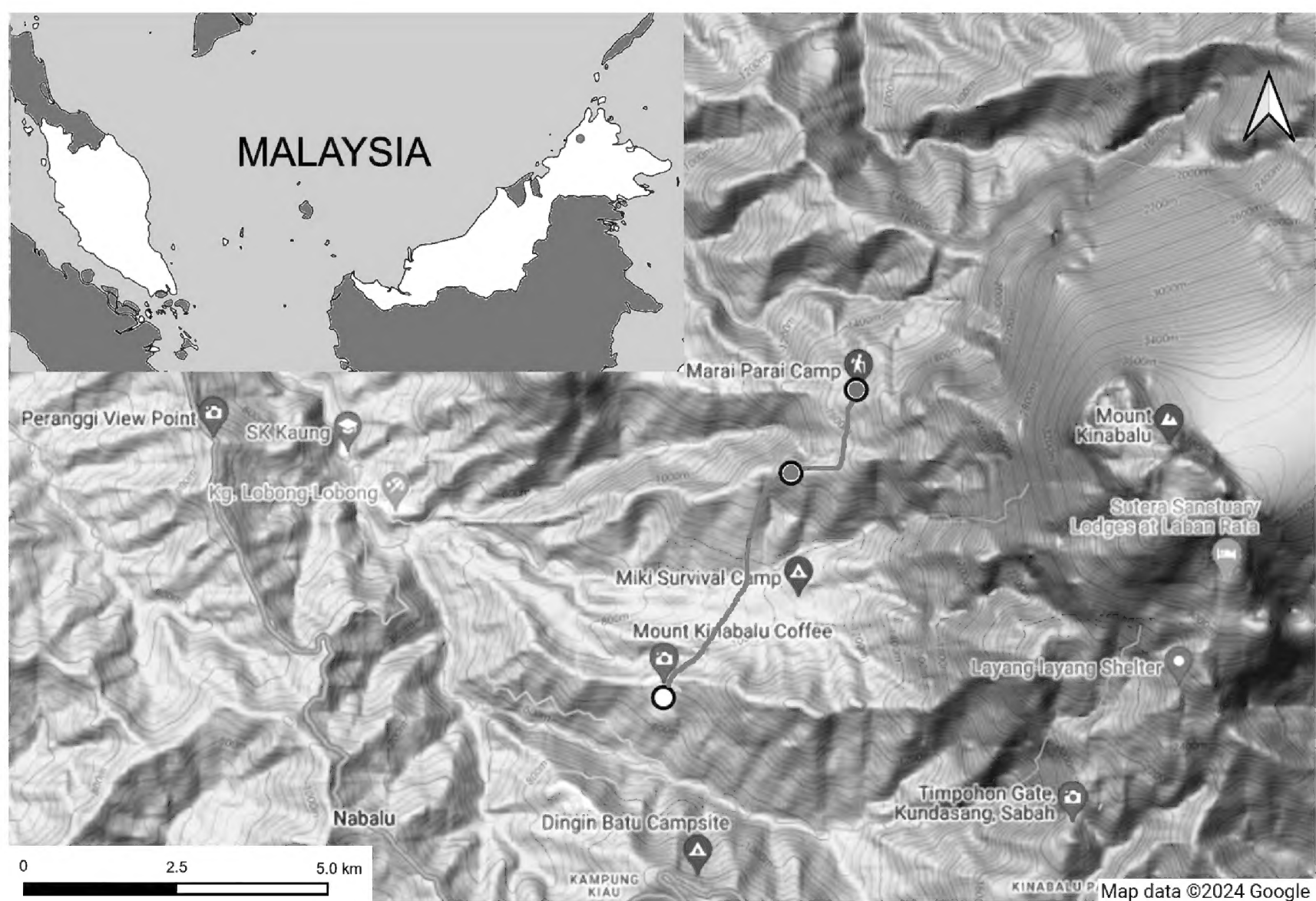


Fig. 1. Map of Kinabalu Park, Sabah. The dots indicate the location of Marai Parai (blue), Nunuk camp (yellow), and Kiau Nuluh (white) near Mount Kinabalu, Sabah, Malaysia (orange).



Fig. 2. Habitats of sampling locations. A. View of the Mount Kinabalu peak from Marai Parai; B. Vegetation along the trail at Marai Parai; C. Vegetation along the trail at Nunuk camp; D. View of Nunuk camp and the surrounding canopy.

Specimen preservation and examination of material.—The specimens were first preserved in absolute analytic-grade ethanol before being pinned and dry-preserved. Dissection of the male titillators or phallus was performed by removing them from the abdominal apex of softened specimens before being cleaned using aqueous potassium hydroxide (KOH) and subsequently preserved in glycerine. The morphological features and male genitalia of the specimens were photographed using the same camera and lens listed above and illuminated by external lighting from a Godox Macro Ring Flash ML-150. Additionally, a PULUZ Folding Portable 550LM Light Photo Lighting Studio Shooting Tent Box Kit with a white backdrop was used to enhance the photography. Adobe Photoshop CC 2014 (Adobe Systems Incorporated, San Jose, CA, USA) was utilized for image editing.

Specimen identification.—Both authors identified the specimens using relevant published keys (Willemse 1921, 1933, 1935, Karny 1925a, 1925b, Beier 1954, Kevan and Jin 1993, Gorochoy 1997, 2002, 2006, 2008a, 2008b, 2014, 2016, 2020, 2021, 2022, Gorochoy and Tan 2011, Ingrisch 2011, 2018, Robillard et al. 2023, Tan 2014, Tan and Kamaruddin 2014, Tumbrinck 2014, Tan et al. 2015, 2019, 2021, 2022, Tan and Wahab 2017, 2018, Skejo et al. 2022). The Orthoptera Species File (OSF) Online Version 5.0/5.0 was used for species classification and nomenclature (Cigliano et al. 2024). The identification was further verified by the following orthopterists: Luc Willemse for Acridoidea, Andrej V. Gorochoy for Stenopelmatoidea, and Josip Skejo, Karmela Adžić, and Maks Deranja for Tetrigoidea.

Depository.—All specimens collected are planned to be deposited in the Entomological Unit of Sabah Park (EUSP), Kinabalu Park, Ranau, Sabah.

Results and discussion

The five-day sampling period yielded 32 species representing nine families. The species from Marai Parai and Nunuk represent 8

of the 17 monophyletic orthopteran superfamilies (sensu Song et al. 2020), covering 50% of the lineages in the orthopteran phylogeny (Tan and Wahab 2018). The suborder Ensifera is represented by 25 species, which is more than in the monophyletic suborder Caelifera (7 species). The most speciose groups are Tettigonioidea (12 species), followed by Grylloidea (6 species), Tetrigoidea (4 species), and Rhaphidophoroidea (2 species). Eumastacoidea and Gryllotalpoidea are each represented by a single species. Twenty-one of the 32 species (65.6%) collected are singletons, suggesting that many species in this region are rare or of low abundance.

Of the 32 species, only one species (*Nisitrus musicus* Ingrisch, 1987) was collected from both sampling locations (Marai Parai and Nunuk camp), suggesting that this species is common. Four species were exclusively collected from Marai Parai (*Traulacris* nr. *erecta*, *Cratioma* cf. *borneense*, *Despoina spinosa* Brunner von Wattenwyl, 1895, *Subtilodecma bilobata*) while the other 27 species were collected from Nunuk camp.

Checklist

Suborder Caelifera
Family Acrididae
Subfamily Catantopinae

Traulacris nr. *erecta*
Fig. 3

Material examined.—EAST MALAYSIA: Sabah • 3♂ 2♀; Ranau, Kinabalu Park, Marai Parai; 14 October 2023; on stem of *Tetraria pilisepala* plant; leg. A.A. Muhammad, Supani T., Jalter M. & Silver P.; EUSP.

Remarks.—This species is very similar to *T. erecta* Willemse, 1933, but differs by the anterior and median femora being yellowish green instead of yellowish brown and apical half of hind tibiae of the same color (greenish blue) as the basal half (instead of

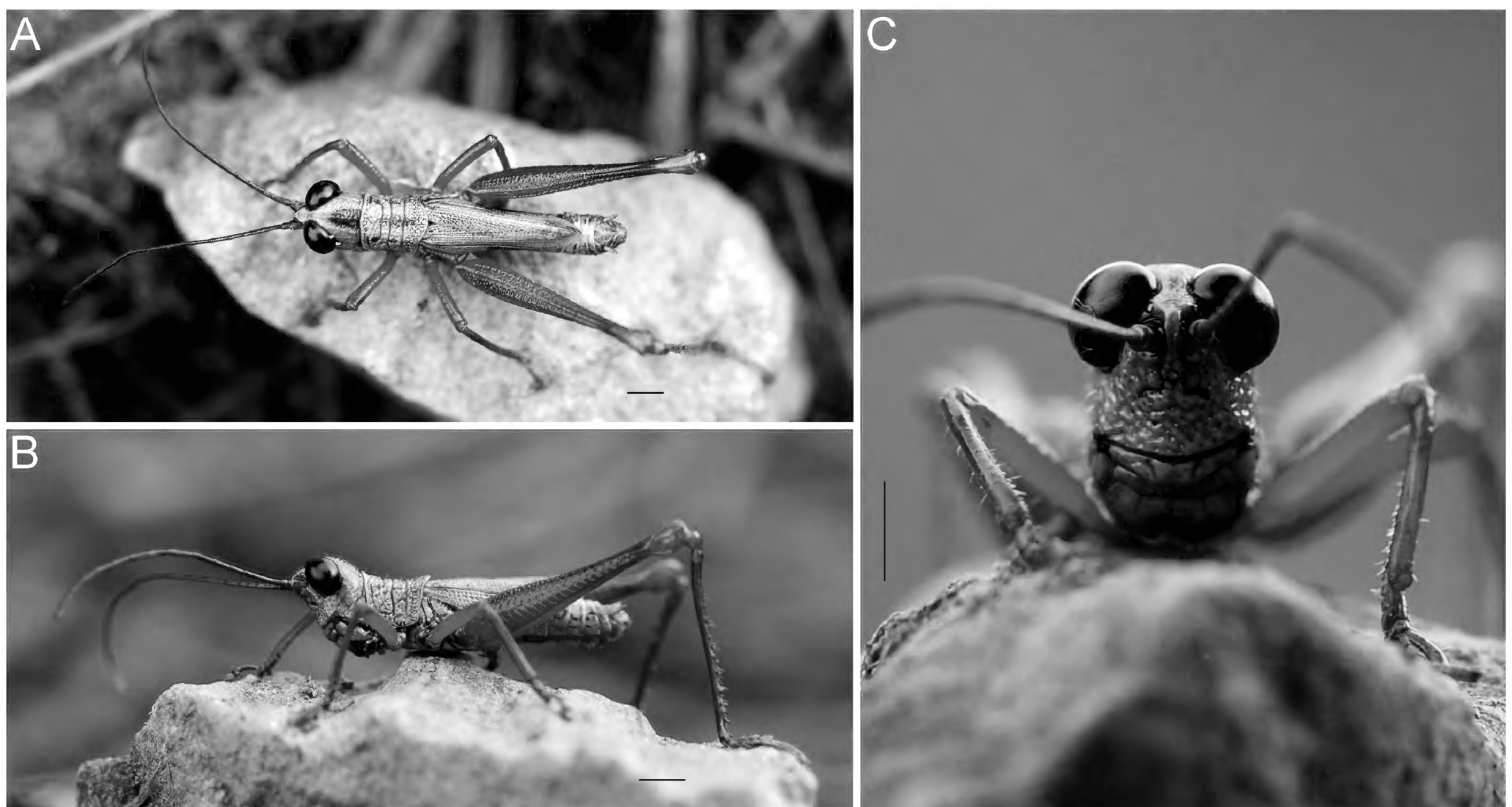


Fig. 3. *Traulacris* nr. *erecta*. A–C. Habitus in dorsal, lateral, and frontal view. Scale bars: 2 mm.

blackish). It was found within the grassy vegetation of Marai Parai, at approximately 1600 m.a.s.l., but not at Nunuk camp. Male and female specimens were identified using the key in Willemse (1933). Our specimen may represent an undescribed species, but comparison to the type specimen(s) is needed for confirmation. Nevertheless, this finding represents the first record of this species at Mount Kinabalu, which is approximately 170 km west of the type locality (Bettotan [=Betotan], Sandakan).

Traulia borneensis Willemse, 1921

Fig. 4

Material examined.—EAST MALAYSIA: Sabah • 1♀; Ranau, Nunuk; 17 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was found on the foliage of understory plants at Nunuk camp. It was identified based on the color description in Willemse (1935) and comparison with type images from OSF (Cigliano et al. 2024). The type locality of this species is

unspecified (North Borneo); hence it is impossible to determine it as a first record for this region (Willemse 1921). However, it is probable that this species is widespread in Borneo, as it is also present in Kuala Belalong, Brunei Darussalam (Tan and Wahab 2018).

Family Chorotypidae
Subfamily Chorotypinae

Chorotypus sp.

Fig. 5

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 17 October 2023; at the wall of a building with light source; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—Only one individual, attracted to the light source at a building at Nunuk camp, was collected at night. This grasshopper can be found in leaf litter on the forest floor (Tan and Kamaruddin 2014). Identification involved the use of the generic key in Willemse (1930) and comparison with the images in OSF (Cigliano et al. 2024).

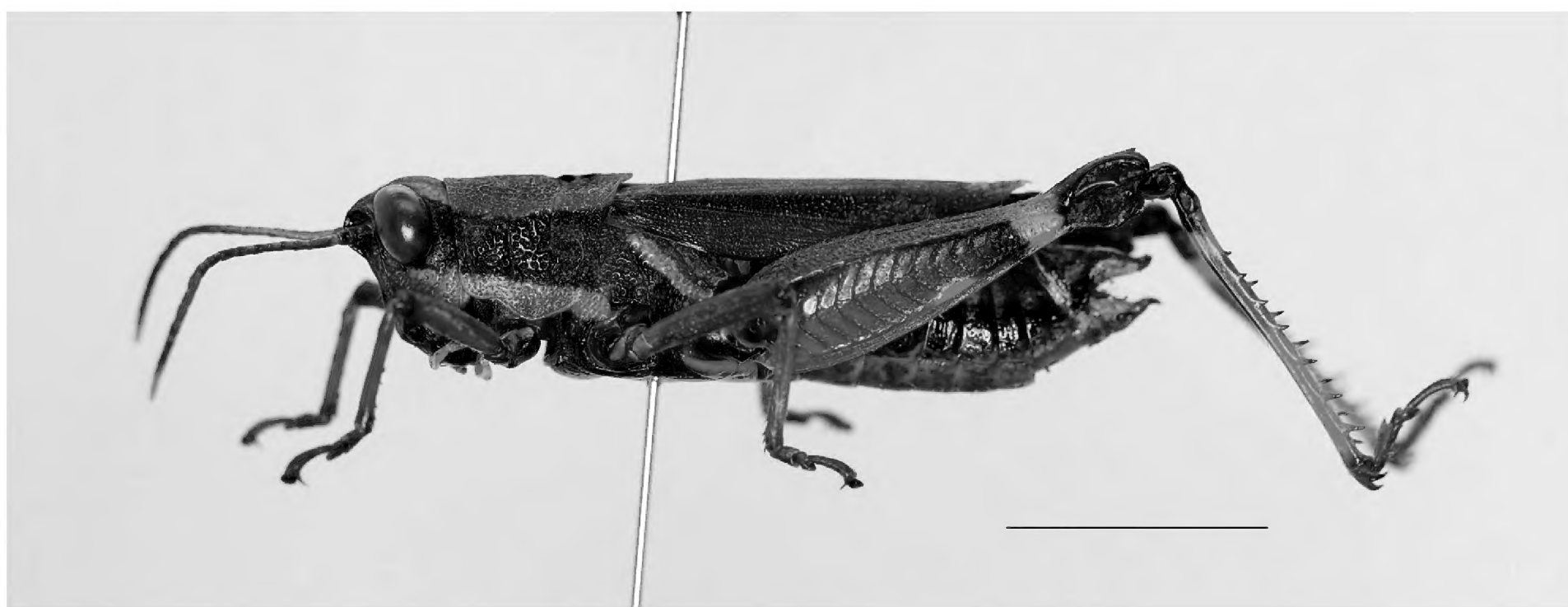


Fig. 4. *Traulia borneensis*. Scale bar: 10 mm.

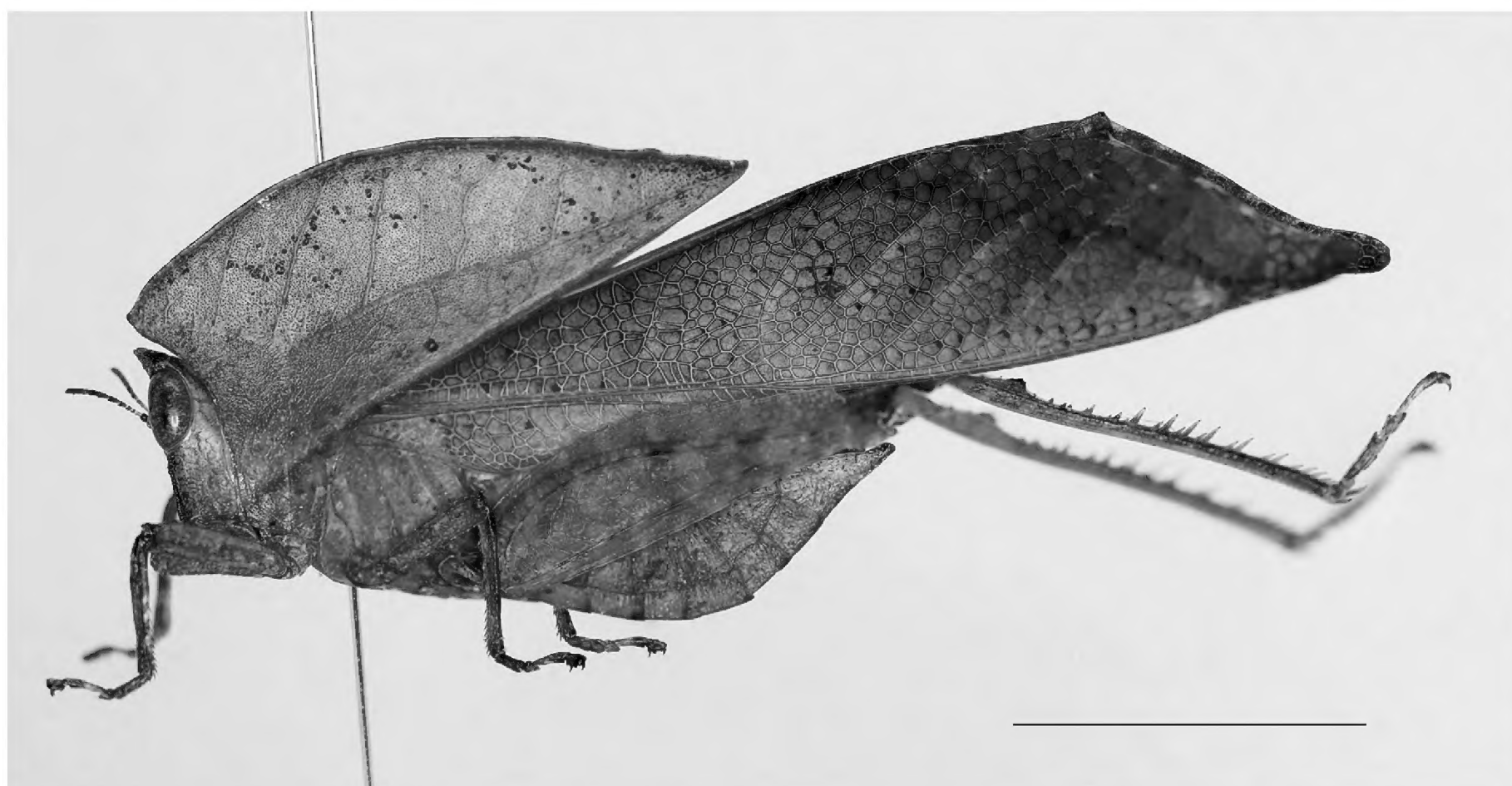


Fig. 5. *Chorotypus* sp. Scale bar: 10 mm.

Family Tetrigidae
Subfamily Cladonotinae

Potua cf. morbillosa
Fig. 6A

Material examined.—EAST MALAYSIA: Sabah • 1♂ 2♀; Ranau, Nunuk; 16 October 2023; on rotten logs; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—Our specimens are similar to *P. morbillosa* Walker, 1871, which is commonly found in Borneo, differing slightly by the number of pronotal humps. Unlike *P. morbillosa*, our specimens have two extra humps in dorsal view (seen as one hump in lateral view) just behind the first hump. Our specimens may represent an undescribed species, but members of this subfamily are known to vary greatly by the shape of their pronotum (Tumbrinck 2014). Hence, more material and alternative analyses are needed for confirmation. This pygmy grasshopper was found on rotten logs along the trail in the community forest area. Morphological identification was verified by J. Skejo, K. Adzic, and M. Deranja and compared to type images in OSF (Cigliano et al. 2024). This finding represents the first official record of this species from Mount Kinabalu and from Sabah. Apart from its type locality in Sarawak, this species has also been recorded in Kuala Belalong, Brunei Darussalam (Tan and Wahab 2018).

Subfamily Metrodorinae

Bolivaritettix apterus Rehn, 1904
Fig. 6B

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 14 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP • 2♀; Ranau, Nunuk; 17 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was collected during the day on the foliage of understory plants along the trail in the community forest near Nunuk camp. It is among the most common Tetrigidae species encountered here. Habitus size is rather large (BL > 1.0 mm) for Metrodorinae. The specimens were compared to images in OSF (Cigliano et al. 2024) for identification. This species is widespread in Borneo, with the type locality in Labuan, which is approximately 170 km southwest of Mount Kinabalu.

Subfamily Scelimeninae

Disconius shelfordi Hancock, 1907
Fig. 6C

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 17 October 2023; on rotten log; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was found on a rotten log on the forest floor. Unlike *Discotettix*, this species lacks elevated frontomedial and other highly elevated projections on its pronotum (Skejo et al. 2022). Identification was also verified by J. Skejo, K. Adzic, and M. Deranja. Previously described from Sarawak (Hancock 1907) and Kalimantan (Cigliano et al. 2024), this is the first record of this species for Mount Kinabalu and Sabah.

Discotettix (Discotettix) belzebuth Serville, 1838
Fig. 7

Material examined.—EAST MALAYSIA: Sabah • 2♂ 2♀; Ranau, Nunuk; 16 October 2023; on rotten log; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species is commonly found in the forests of Borneo. In this study, both *Disconius shelfordi* and *D. belzebuth* were found co-occurring on a rotten log. This specimen was recognized by its flattened and widened subapical antennal segments and multiple projections on the pronotum. Further identification was done using the description in Skejo et al. (2022).

Suborder Ensifera
Family Gryllidae
Subfamily Eneopterinae

Nisitrus musicus Ingrisch, 1987
Fig. 8

Material examined.—EAST MALAYSIA: Sabah • 1♂ 2♀; Ranau, Kinabalu Park, Marai Parai; 14 October 2023; on foliage; leg. A.A. Muhammad, Supani T., Jalter M. & Silver P.; EUSP • 2♀; Ranau, Nunuk; 16 October 2023; on foliage; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP • 1♀; Ranau, Nunuk; 17 October 2023; on foliage; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was collected during both the day and night at Marai Parai and Nunuk camp, and was the most common Gryllidae species encountered. During the day, males can be heard calling on plant foliage. The specimens were compared to the descriptions and images in Tan et al. (2021) and Robillard et al. (2023) for identification.

Subfamily Itarinae

Itara sp.
Fig. 9

Material examined.—EAST MALAYSIA: Sabah • 1♀; Ranau, Nunuk; 17 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—Only one female specimen was collected on the foliage of understory plants at Nunuk camp. It resembles the congeners of *Itara* by the fore tibiae with open outer but slit-like inner tympanum (Gorochoy 1997). Determination of the subgenus and species name was not possible because the only descriptions available are of males.

Subfamily Landrevinae

Repapa trusmadi Gorochoy, 2016
Fig. 10

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 16 October 2023; in crevices of rotten log; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was collected within the bark crevices of a rotten log at Nunuk camp. During the night, males can be heard calling from these crevices. Species of this genus are similar to

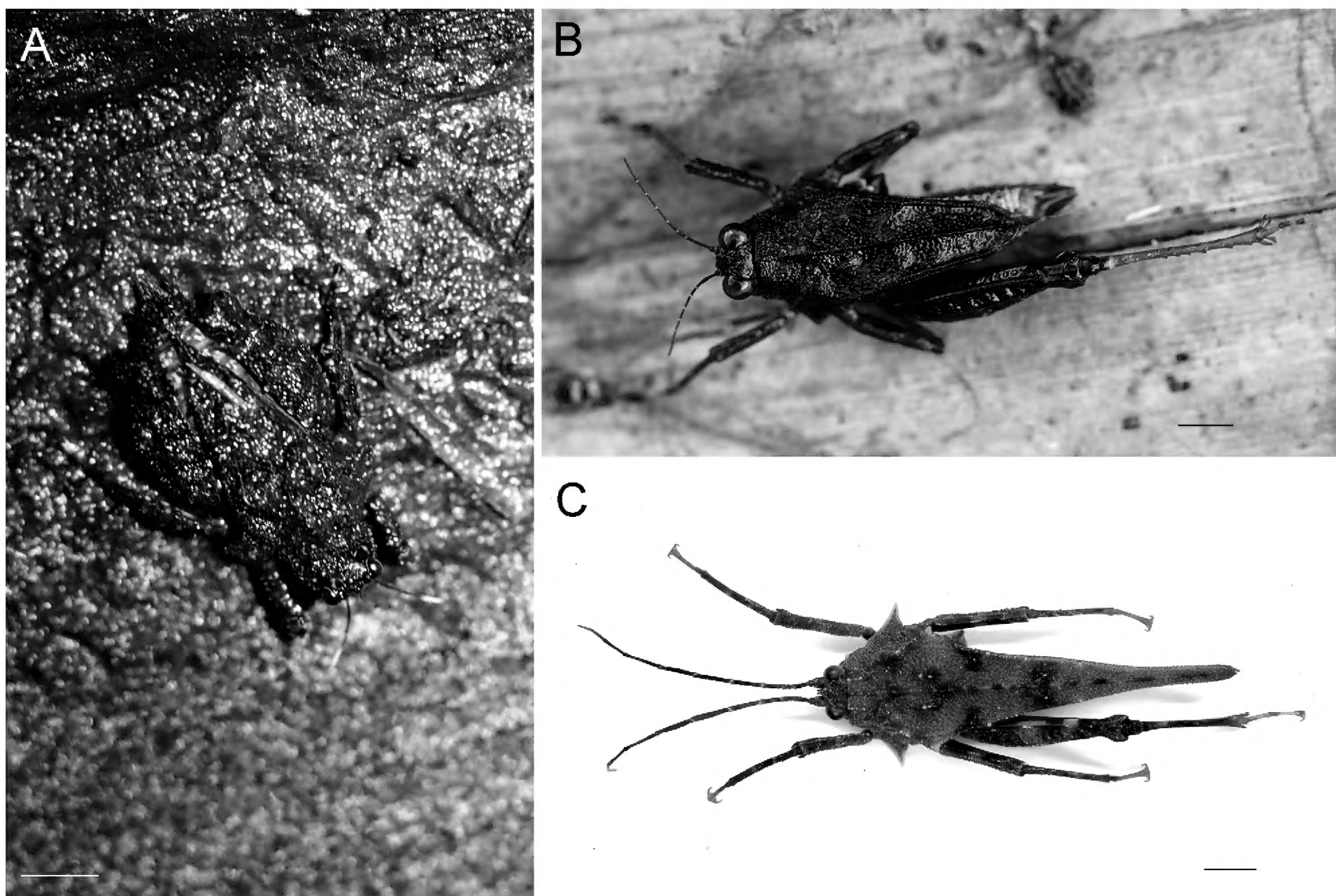


Fig. 6. Tetrigidae. A. *Potua* cf. *morbillosa*; B. *Bolivaritettix apterus*; C. *Disconius shelfordi*. Scale bars: 2 mm.

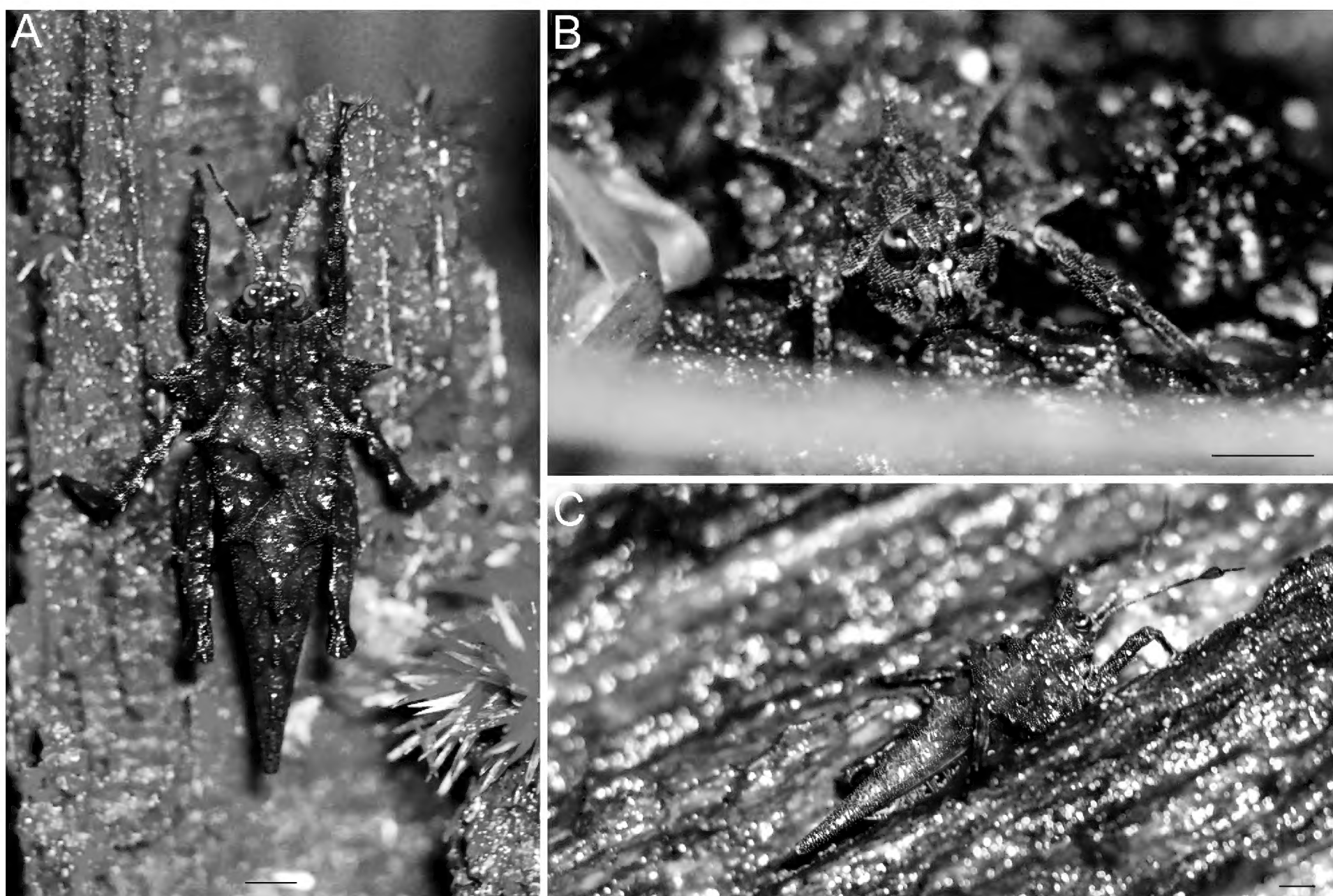


Fig. 7. *Discotettix belzebuth*. A–C. Habitus in dorsal, frontal, and lateral view. Scale bars: 2 mm.

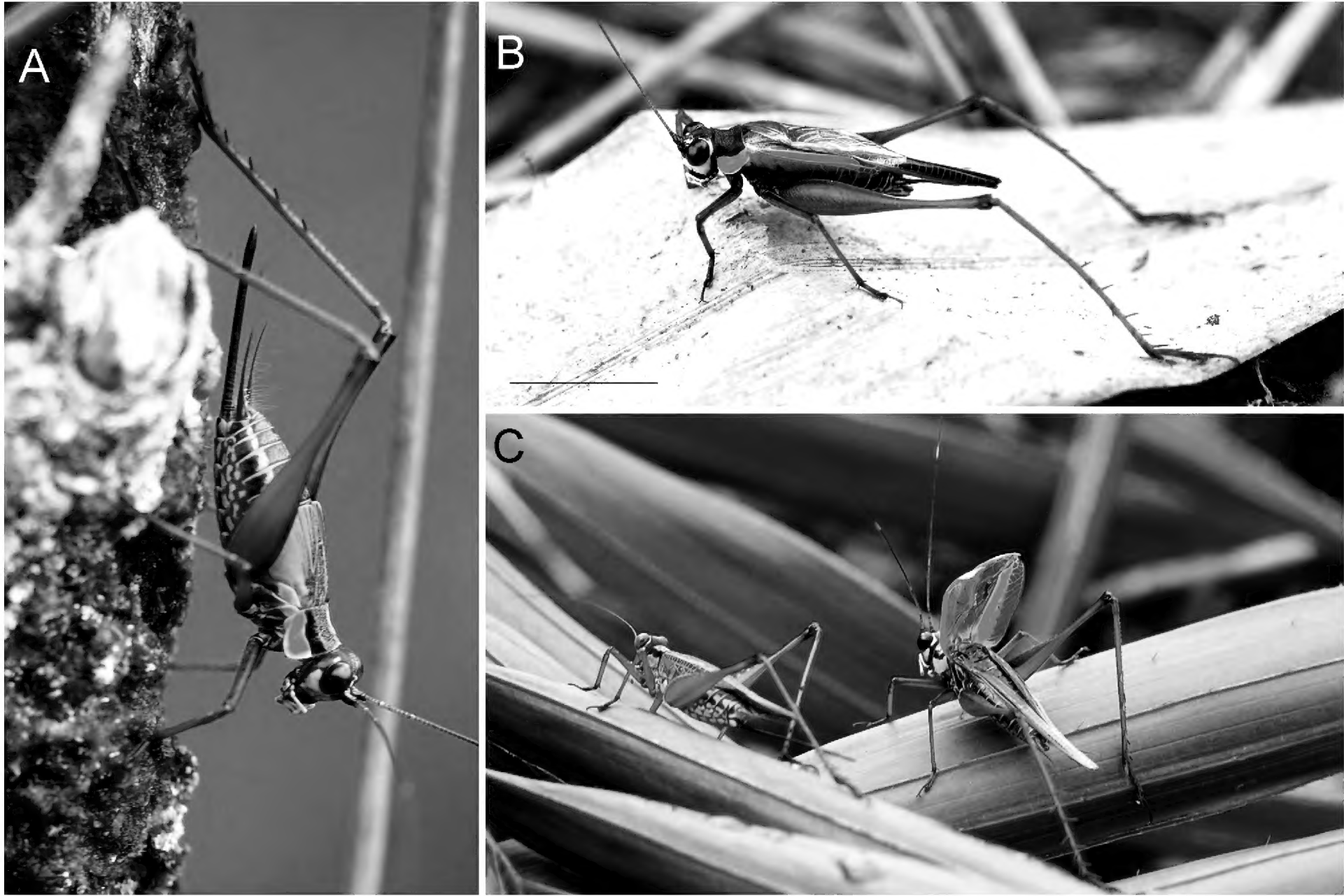


Fig. 8. *Nisitrus musicus*. A. Nymph; B. Adult male in dorsolateral view; C. Adult male (right) and female (left). Scale bar: 10 mm.

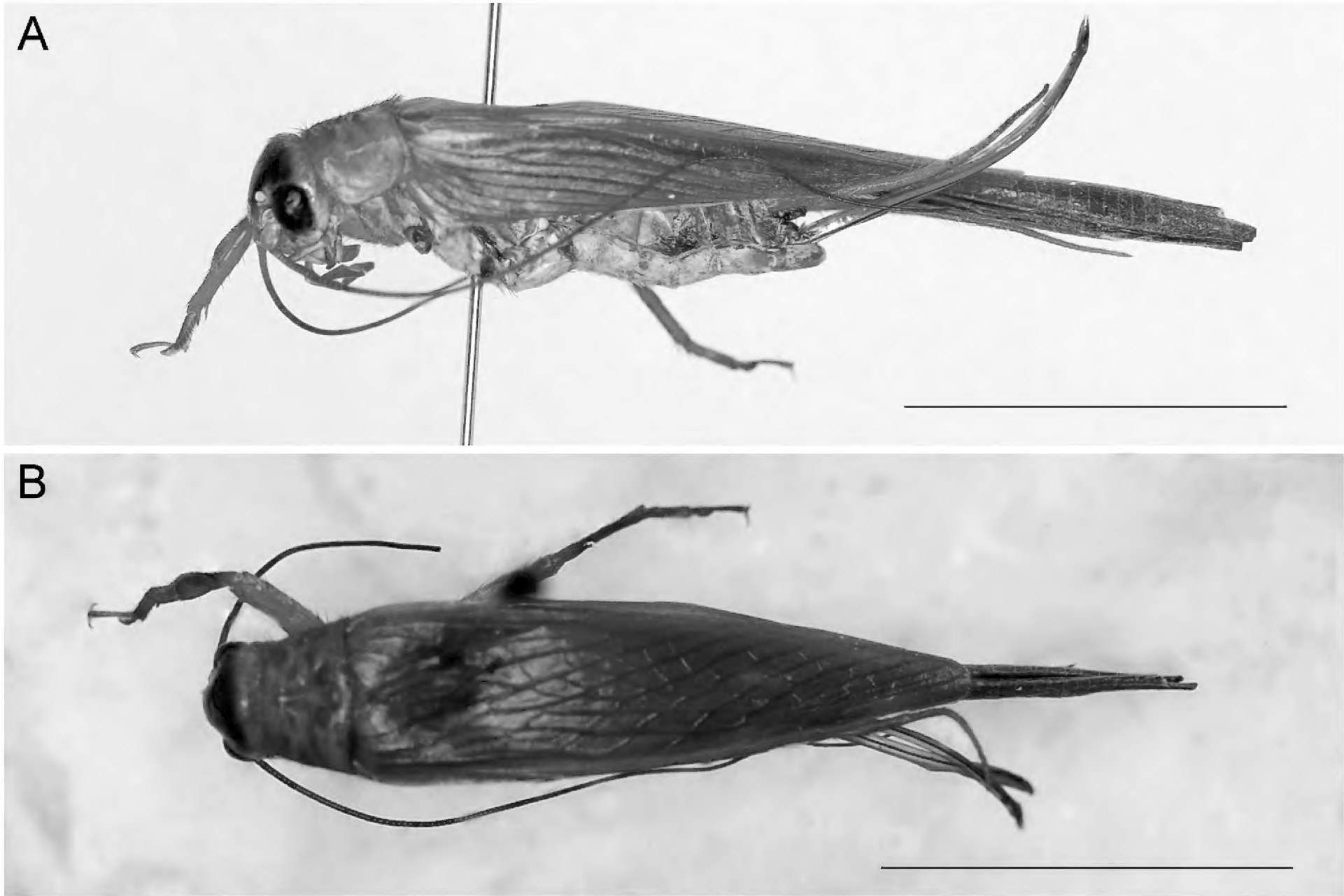


Fig. 9. *Itara* sp. A. Lateral view; B. Dorsal view. Scale bars: 10 mm.

those of the genus *Duolandrevus* Kirby, 1906 in general appearance and in the presence of outer and inner tympana on the fore tibiae, but *R. trusmadi* differs in their male genitalia by having a long and rather narrow unpaired posteromedian epiphallic lobule, long posterolateral epiphallic lobes with the distal parts curved upwards, and rather long and semitubular rachis (Gorochov 2016). This represents the first record of this species from Mount Kinabalu, with its type locality Mount Trusmadi situated 60 km south.

Family Oecanthidae
Subfamily Podoscirtinae

Aphonoides sp.
Fig. 11

Material examined.—EAST MALAYSIA: Sabah • 1♀; Ranau, Nunuk; 17 October 2023; on tree trunk; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—A female specimen was collected from a tree trunk in the forest near Nunuk camp. It resembles congeners of *Aphonoides* by the inner tympanum open but outer one obliterated, tegminal Sc with several normal branches, ovipositor with apex rounded, and large teeth on hind and ventral surfaces (Gorochov 2006). Determination of the species name is not possible without males since most species from Borneo were described based only on males. Additionally, many species of this genus cannot be distinguished by morphology alone, although no sexual dimorphism is typically observed.

Truljalia parvispinosa Chopard, 1930
Fig. 12

Material examined.—EAST MALAYSIA: Sabah • 1♂ 1♀; Ranau, Nunuk; 17 October 2023; at the wall of a building with a light source; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

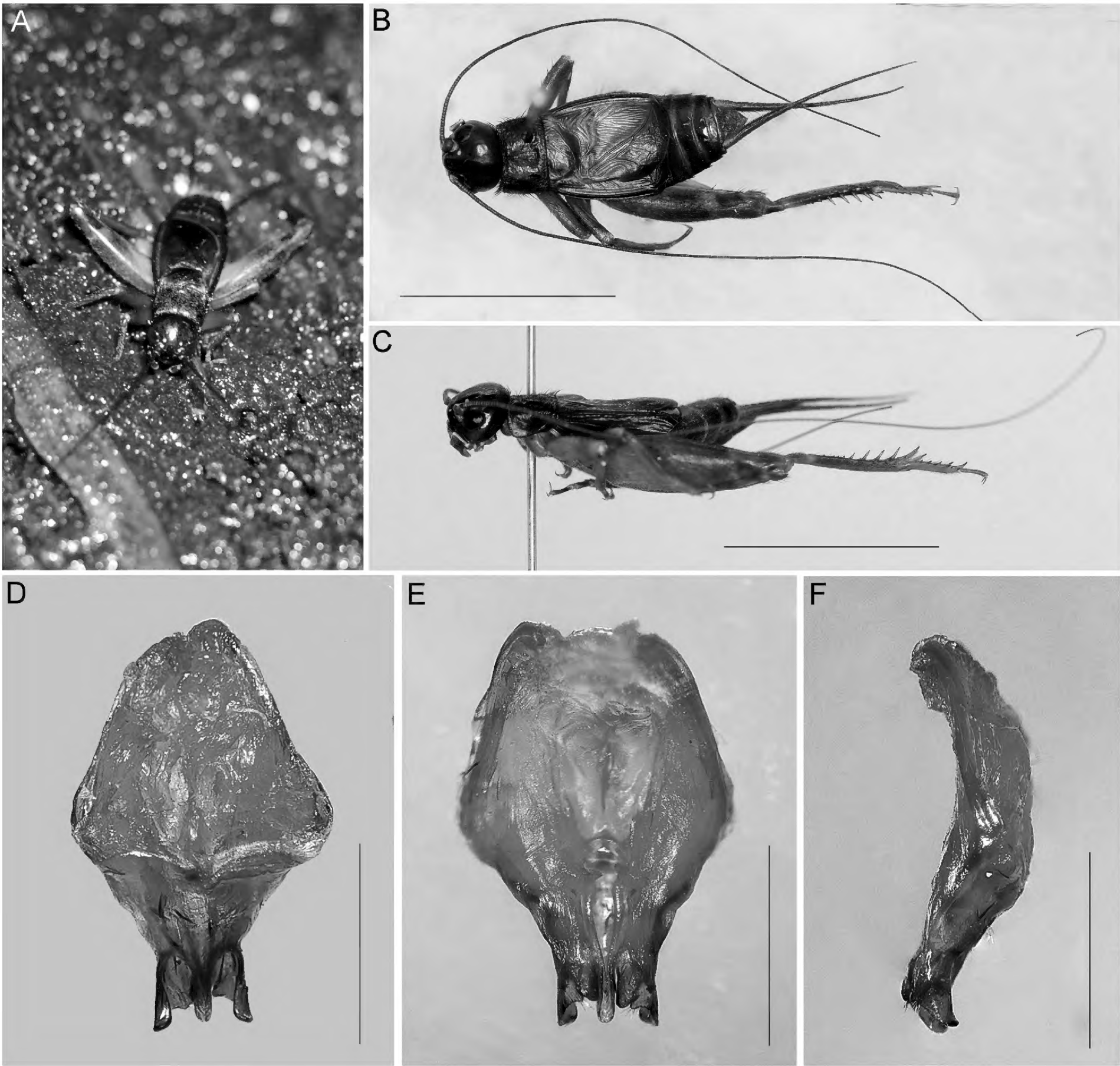


Fig. 10. *Repapa trusmadi*. A–C. Habitus in frontal, dorsal, and lateral view; D–F. Male genitalia from dorsal, ventral, and lateral view. Scale bars: 10 mm (B, C); 1 mm (D, E, F).

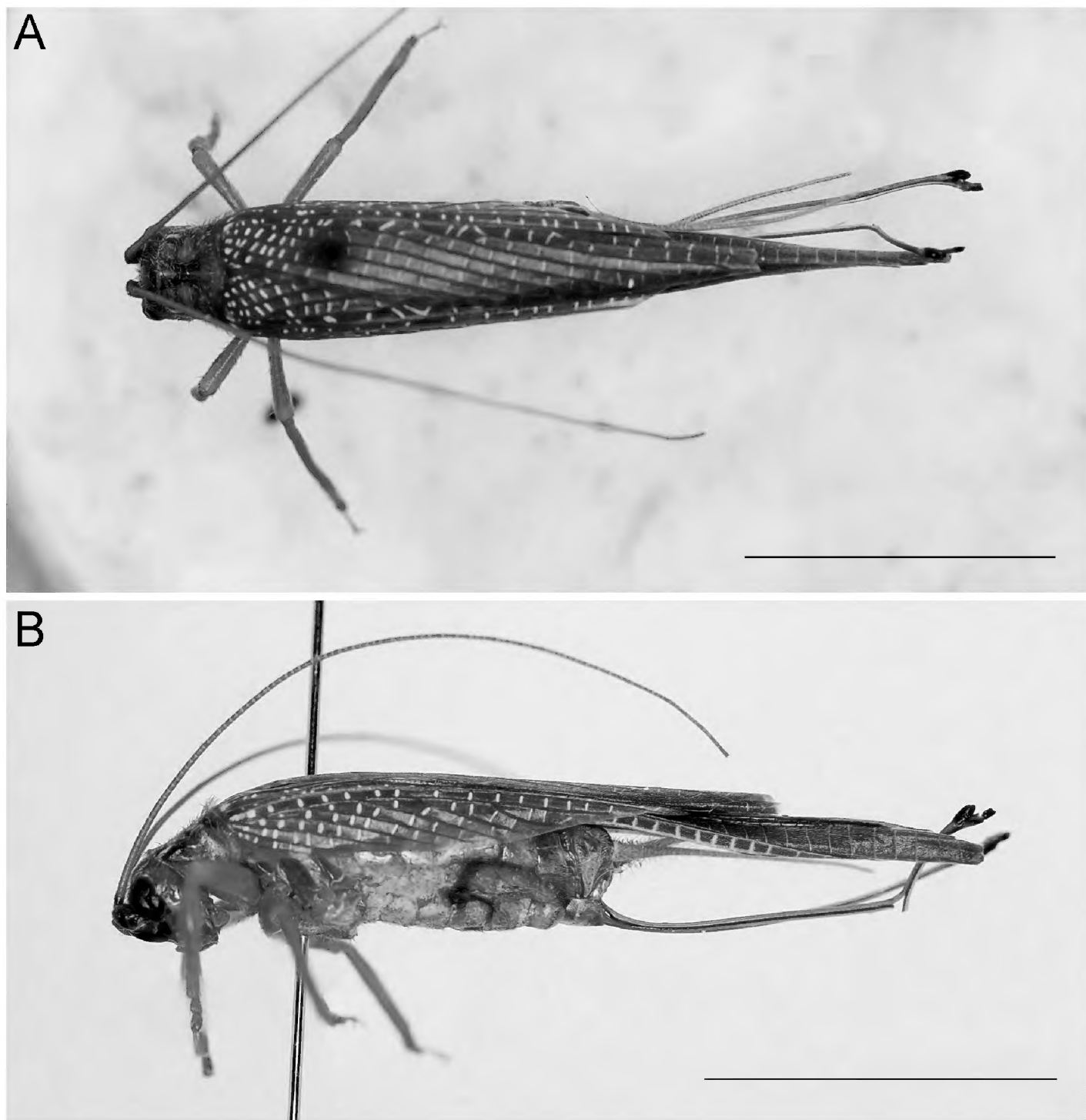


Fig. 11. *Aphonoides* sp. A, B. Habitus in dorsal and lateral view. Scale bars: 10 mm.

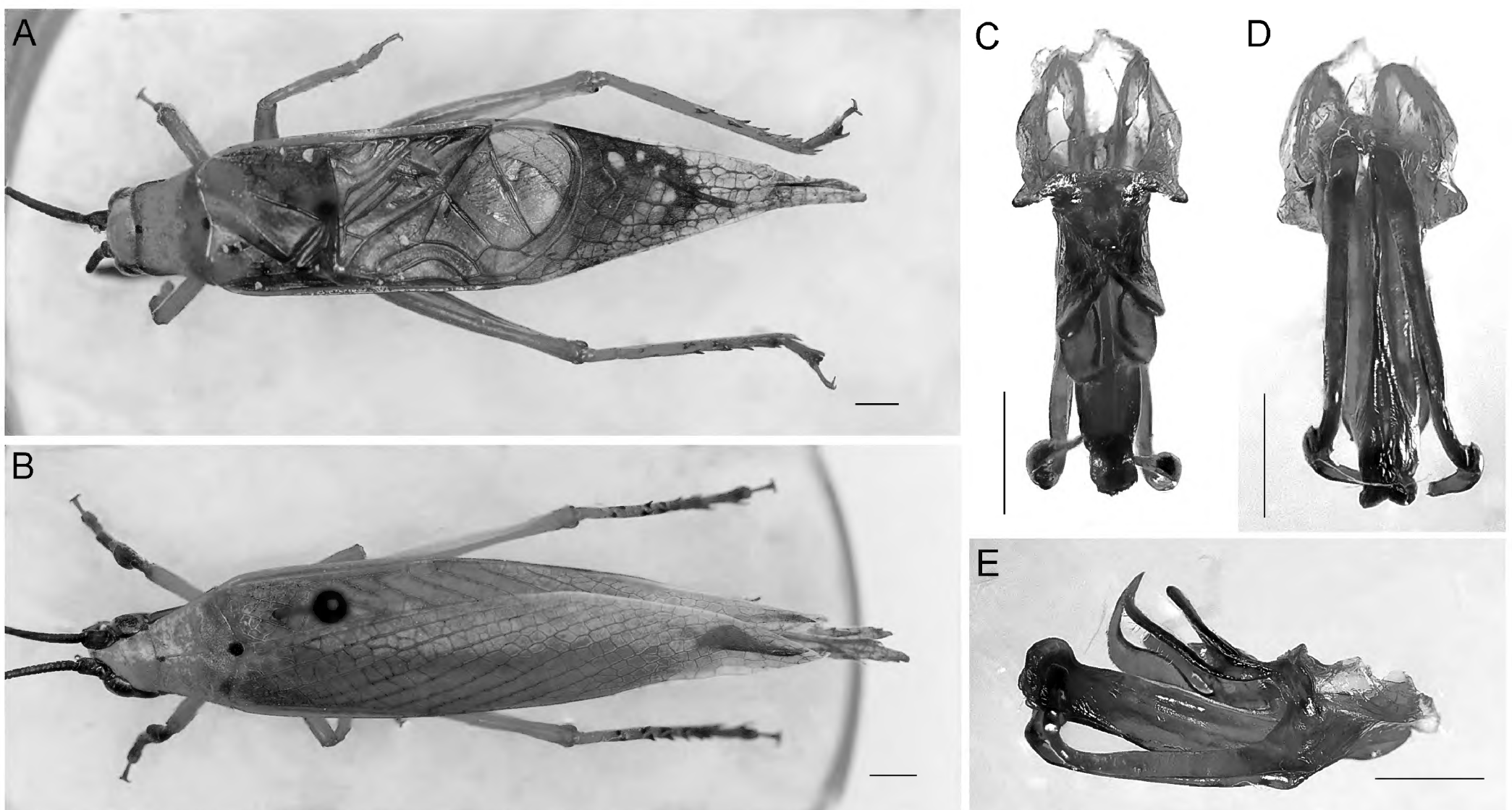


Fig. 12. *Truljalia parvispinosa*. A. Male; B. Female; C–E. Male genitalia in dorsal, ventral, and lateral view. Scale bars: 1 mm.

Remarks.—This species was attracted to the light from a building at Nunuk camp. The specimens were compared to images in OSF (Cigliano et al. 2024) for identification. Male genitalia resemble the description by Gorochov (2002). Apart from its type locality in Sarawak, this species has also been recorded in Mesilau, which is situated about 10 km south of Mount Kinabalu, Sabah (Gorochov 2002).

Family Phalangopsidae
Subfamily Phalangopsinae

Anemozara (Anemozara) vera Gorochov, 2014

Fig. 13

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 14 October 2023; on forest floor; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was collected during the day on the forest floor along the trail in the community forest area near Nunuk camp. The male genitalia resemble the description by Gorochov (2014). This represents the first record of this species from Mount Kinabalu; its type locality is Mount Trusmadi, which is 60 km south of Mount Kinabalu, Sabah.

Family Gryllotalpidae
Subfamily Gryllotalpinae
Tribe Gryllotalpini

Gryllotalpa sp.

Fig. 14

Material examined.—EAST MALAYSIA: Sabah • 1 nymph; Ranau, Nunuk; 16 October 2023; in crevice of rotten log; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—Only one individual of this species was collected. Found within the crevice of a rotten log, the specimen was identified as a nymph due to the underdeveloped wings and genitalia. Species identification is difficult without an adult or a calling sound recording.

Family Rhaphidophoridae
Subfamily Rhaphidophorinae
Tribe Rhaphidophorini

Rhaphidophora cf. *curta*

Fig. 15

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 17 October 2023; in rotten tree stump; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—Only one male (BL < 20 mm) was collected inside a rotten tree stump at Nunuk camp. This group is speciose, and it can be hard to identify Southeast Asian representatives (A.V. Gorochov in litt.). The habitus closely resembles that of *R. curta* Gorochov, 2013 described from Mt. Trus Madi [= Trusmadi], but it differs by the abdominal apex. The specimens were compared to images from OSF (Cigliano et al. 2024) for identification.

Rhaphidophora sp.

Fig. 16

Material examined.—EAST MALAYSIA: Sabah • 1♂ 1♀; Ranau, Nunuk; 17 October 2023; in rotten tree stump; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was collected on a rotten tree stump at Nunuk camp, albeit a different stump than that on which *Rhaphidophora* cf. *curta* was found. Habitus and size closely resemble that of *R. kinabaluensis* (BL = ±30 mm), but both differ by male

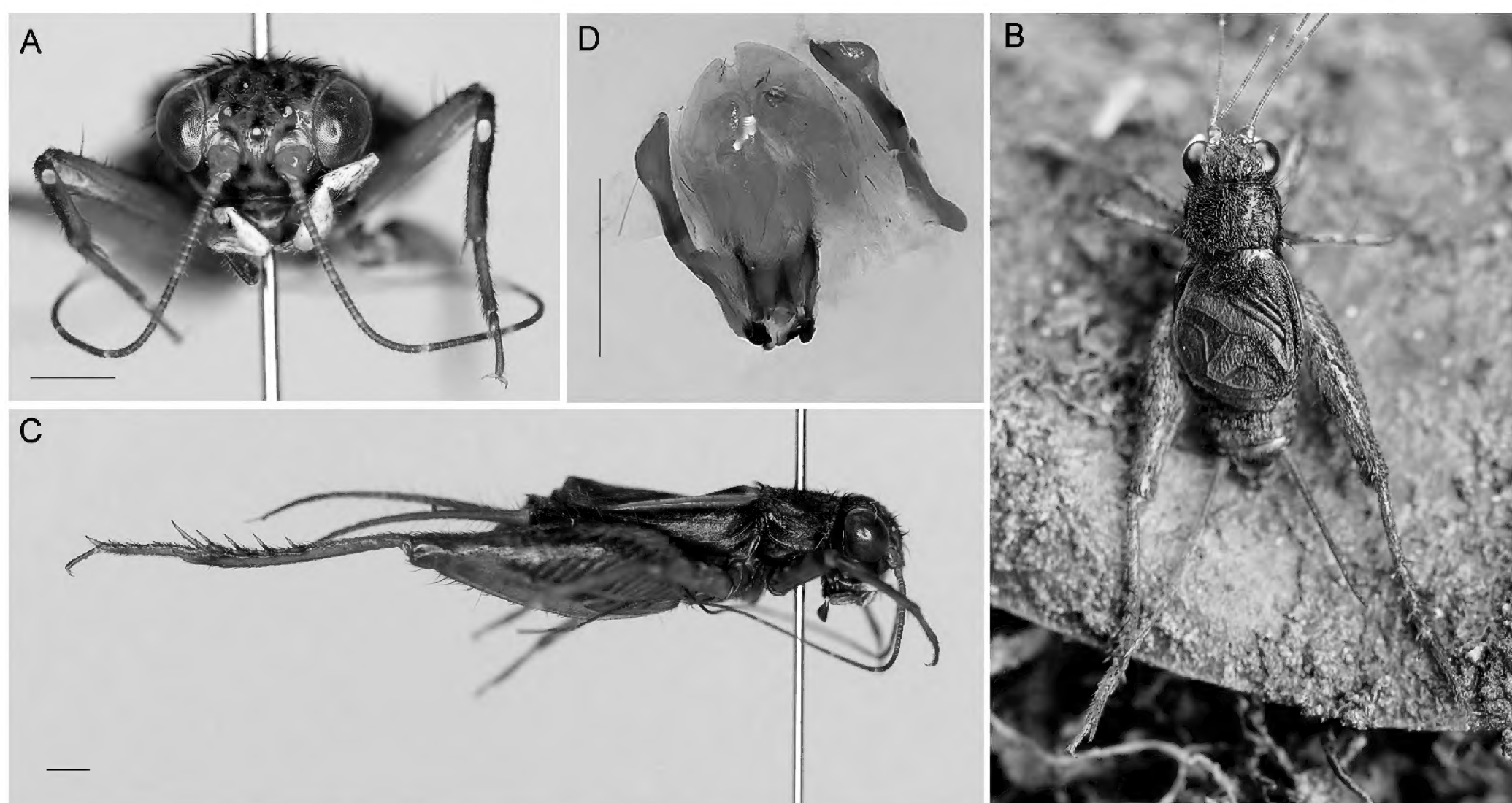


Fig. 13. *Anemozara (Anemozara) vera*. A–C. Habitus in frontal, dorsal, and lateral view; D. Male genitalia in dorsal view. Scale bars: 1 mm.

abdominal apex. This group is speciose, and can be difficult to identify for Southeast Asian representatives (A.V. Gorochov in litt.).

Family Gryllacrididae

Zalarnaca cf. *teuthroides*

Fig. 17

Material examined.—EAST MALAYSIA: Sabah • 1♂ 1♀; Ranau, Nunuk; 17 October 2023; in rotten tree stump; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—Only one male specimen was collected on the foliage of understory plants at Nunuk camp. Genus identification was based on descriptions by Gorochov (2008a) and Ingrisch (2018) and verified by A. V. Gorochov. Species identification follows Karny (1925b). This specimen closely resembles *Z. teuthroides* Karny, 1925b in body length (17 mm), its tawny brown habitus, fore and middle tibiae with five long spines, apical margin of sub-genital plate “W” shaped with short and conical cerci, and ninth abdominal tergite with two strongly incurved projections; it differs in tegmina length not twice as long as the whole body. However, comparison to the type specimen is needed to confirm this species

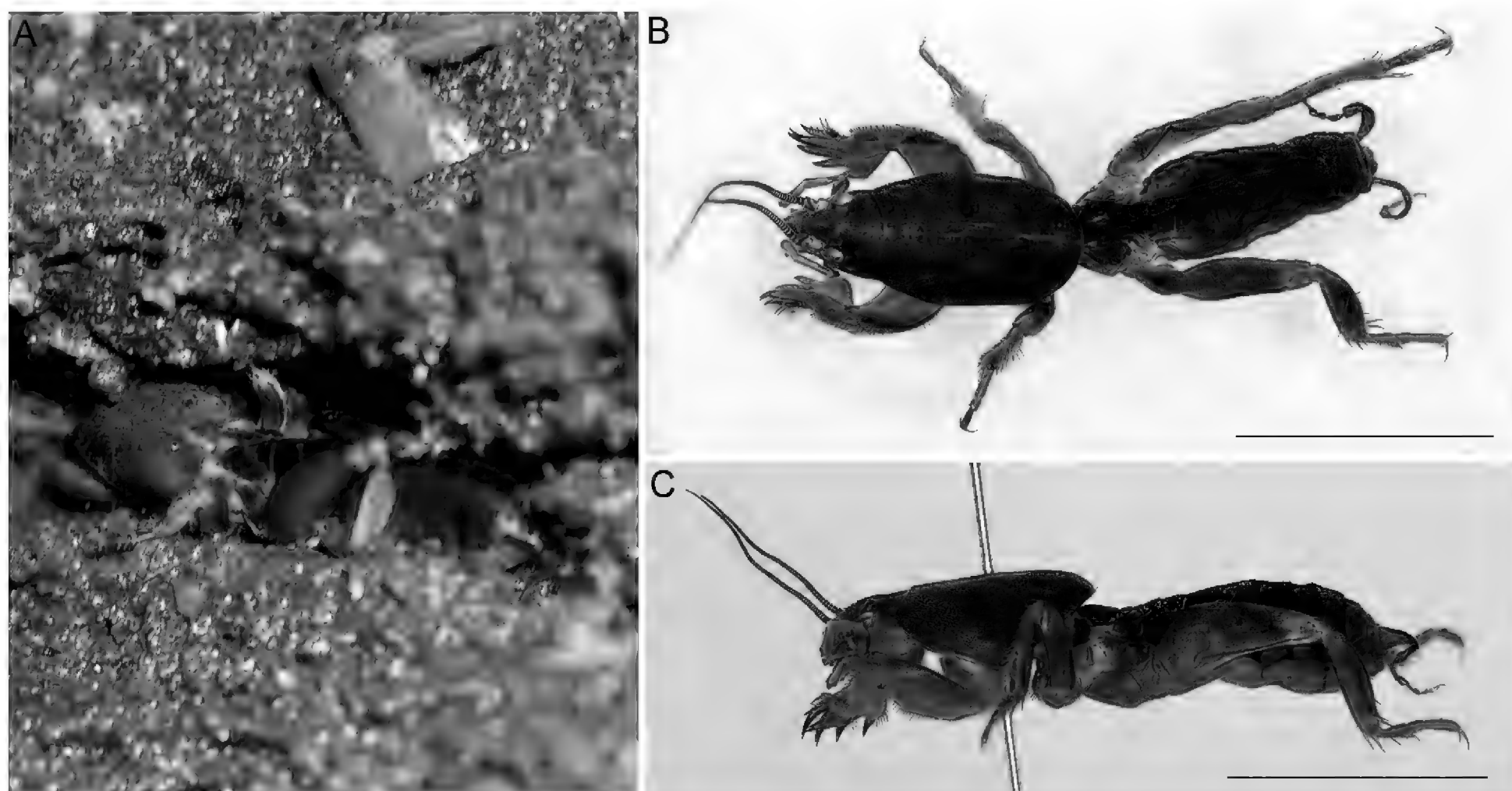


Fig. 14. *Gryllotalpa* sp. A–C. Habitus in postolateral, dorsal, and lateral view. Scale bars: 10 mm.

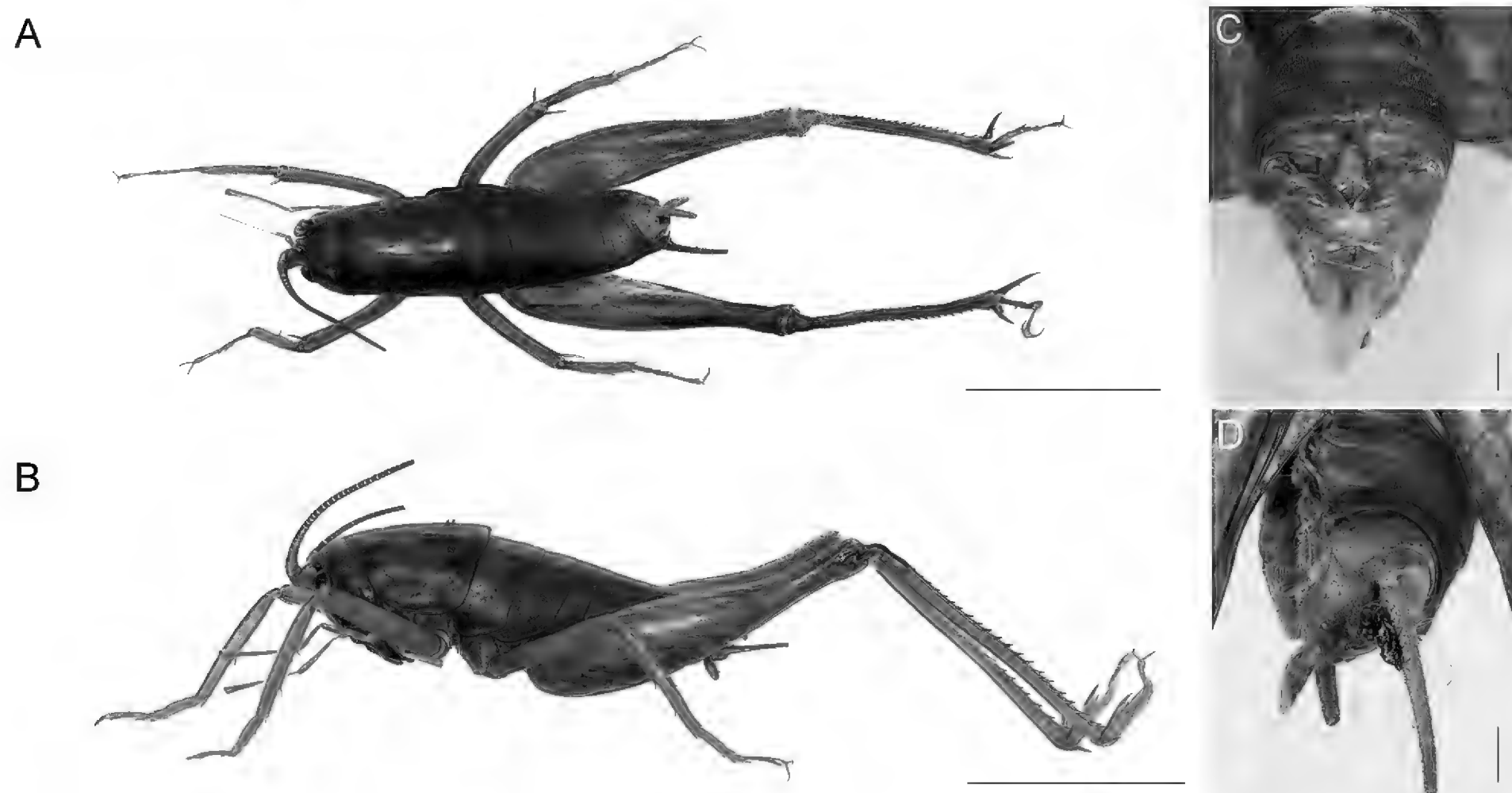


Fig. 15. *Rhaphidophora* cf. *curta*. A, B. Male in dorsal and lateral view; C, D. Male abdominal apex in dorsal and ventral view. Scale bars: 10 mm (A, B); 1 mm (C, D).

identification (Tan 2014, Tan et al. 2019); thus, until a revision of the genera of Asiatic Gryllacridinae is completed, the determination of the species is problematic (A.V. Gorochoy, in litt.). This is the first record of this species at Mount Kinabalu and Sabah. The type locality is Mount Dulit, Sarawak, which is more than 400 km southwest of Mount Kinabalu, Sabah.

Caustogryllacris sp.

Fig. 18

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Kinabalu Park, Marai Parai; 15 October 2023; on tree branch; leg. A.A. Muhammad, Supani T., Jalter M. & Frederick G.; EUSP.

Remarks.—Only one male specimen, found on a tree branch, was collected. The specimen resembles members of the genus *Caustogryllacris* Karny, 1937 by small habitus (BL = 16 mm) with its wings surpassing hind knees, male ninth abdominal tergite globular with the apical area split in the midline by a fine membrane, and a pair of long oval swellings at the apical margin of the ninth tergite that carries a short tooth at the ventral margin

(Ingrisch 2018). Until a revision of the genera of Asiatic Gryllacridinae is completed, the determination of the species is problematic (A.V. Gorochoy, in litt.).

Monseremus appendiculatus Ingrisch, 2018

Fig. 19

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 17 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T., Jalter M. & Frederick G.; EUSP • 1♀; Ranau, Nunuk; 17 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was collected at night on the foliage of understory plants at Nunuk camp. The specimens were identified using the dichotomous keys of Ingrisch (2018) and Tan et al. (2022). So far, there are only two species known in this genus, and this species is widespread in Sabah. Apart from its type locality in Por-ing (16 km east of Mount Kinabalu), this species has also been recorded from Mount Silam (220 km southeast of Mount Kinabalu) (Ingrisch 2018, Tan et al. 2022).

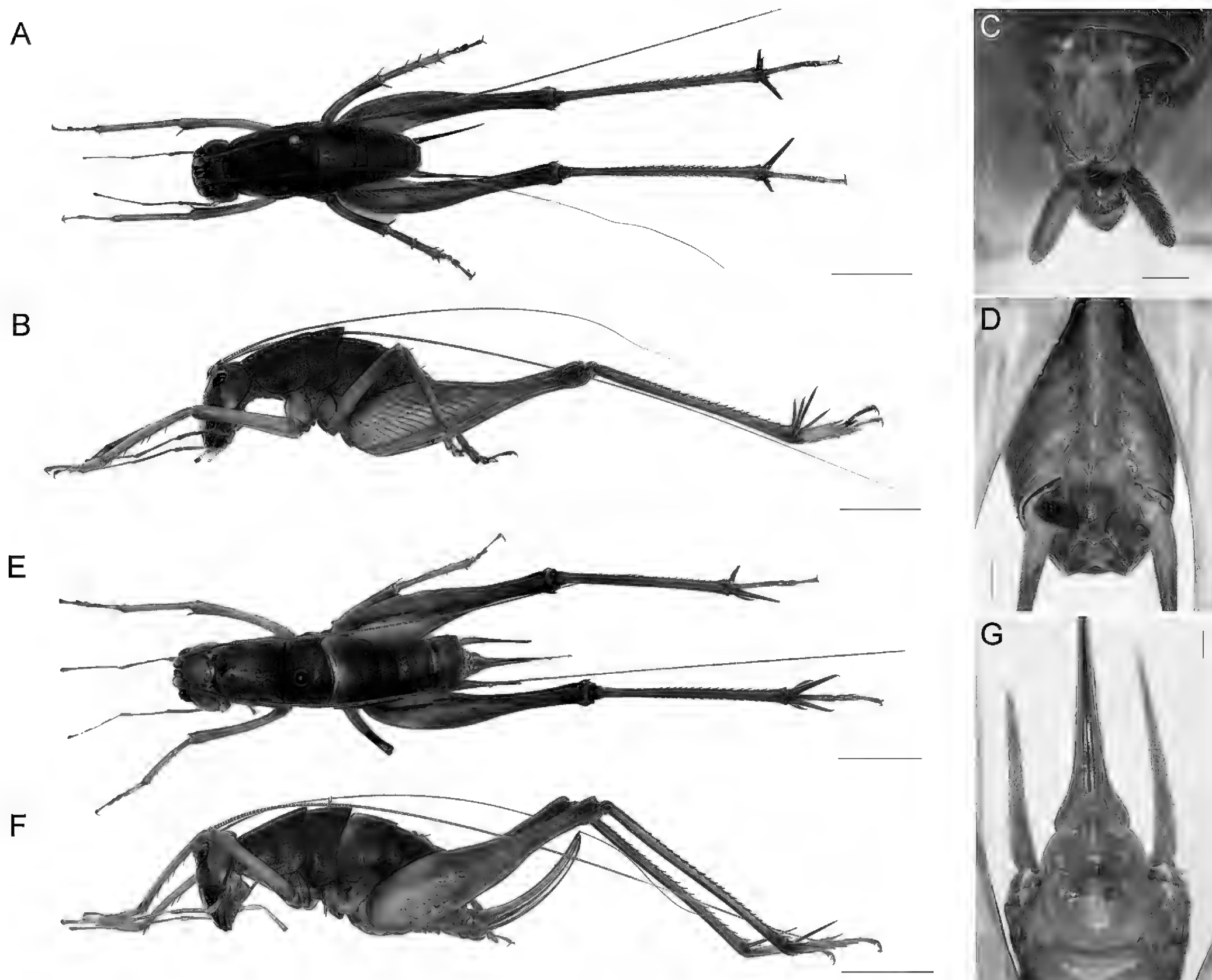


Fig. 16. *Rhaphidophora* sp.2. A, B. Male in dorsal and lateral views respectively; C, D. Male abdominal apex in dorsal and ventral view; E, F. Female in dorsal and lateral view; G. Female subgenital plate. Scale bars: 10 mm (A, B, E, F); 1 mm (C, D, G).

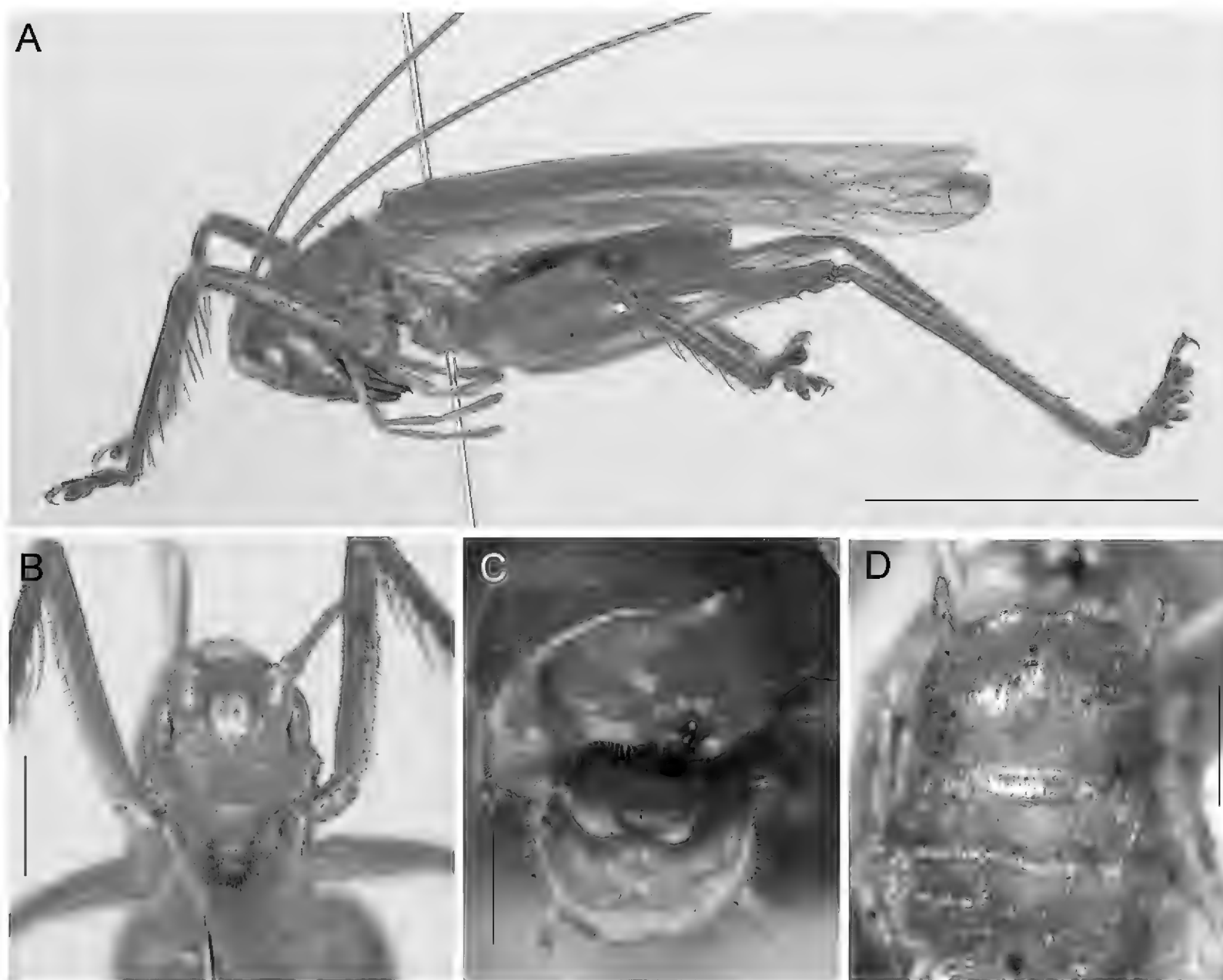


Fig. 17. *Zalarnaca cf. teuthroides*. A, B. Habitus in dorsal and frontal view; C. Male abdominal apex in dorso-apical view; D. Subgenital plate in ventral view. Scale bars: 10 mm (A); 1 mm (B, C, D).

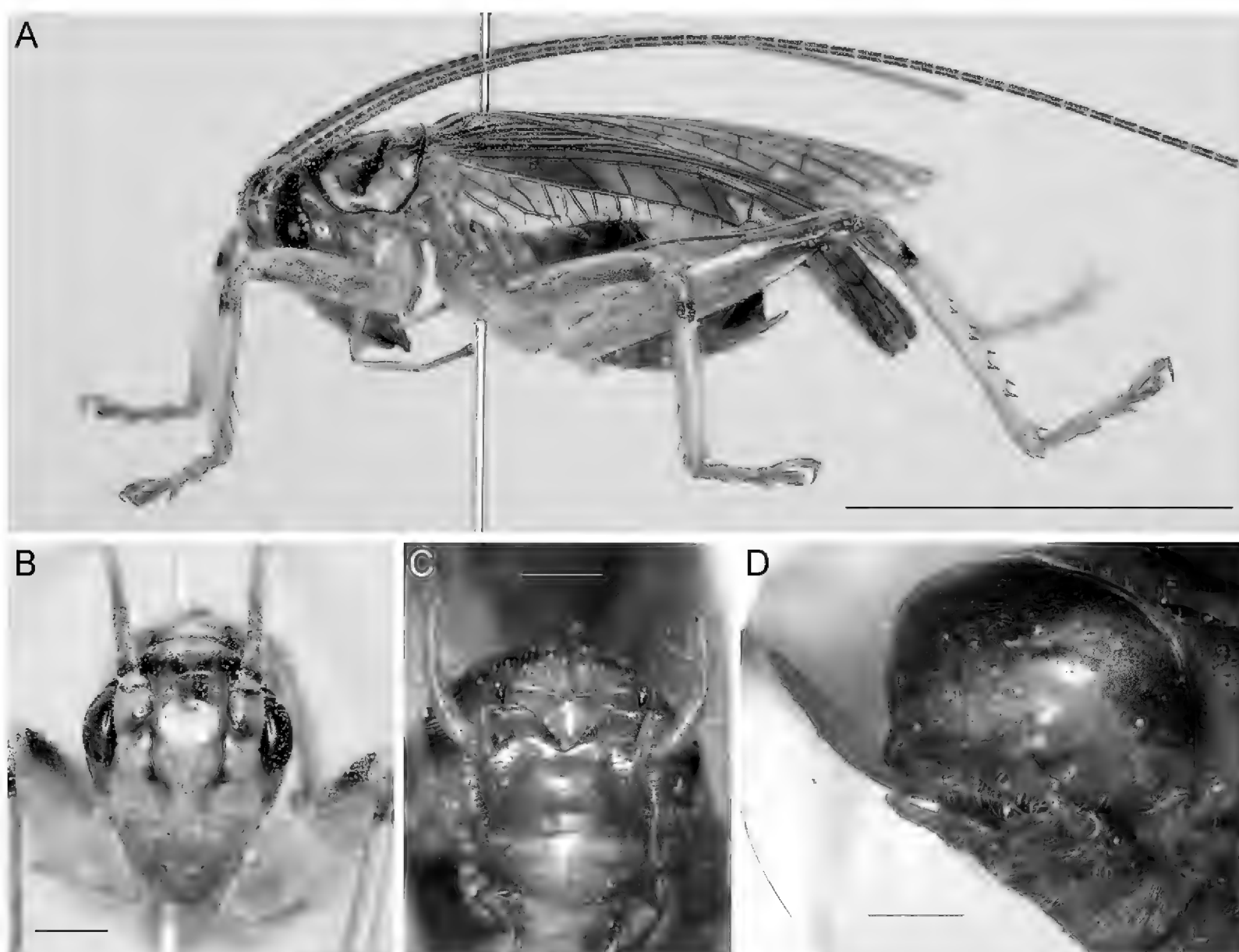


Fig. 18. *Caustogryllacris* sp. A, B. Habitus in dorsal and frontal view; C. Subgenital plate in ventral view; D. Male abdominal apex in oblique apical view. Scale bars: 10 mm (A); 1 mm (B, C, D).

Family Stenopelmatidae
Subfamily Stenopelmatinae
Tribe Siini

Sia bugajus Gorochoy, 2021
Fig. 20

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 17 October 2023; on the ground; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—One male specimen was collected on the ground at Nunuk camp. The specimen was identified using the keys by Willemse (1933) and Gorochoy (2020). So far, this is the only species of this genus recorded from Borneo. It differs from congeners by the shape of the abdominal apex and the subgenital plate (Gorochoy 2022). This represents the first record of this species at Mount Kinabalu; its type locality is Crocker Range National Park near Keningau, which is approximately 40 km south of Mount Kinabalu, Sabah.

Family Tettigoniidae
Subfamily Conocephalinae
Tribe Agraeciini

Eumacroxiphus (Eumacroxiphus) caudatus Ingrisch, 1998
Fig. 21

Material examined.—EAST MALAYSIA: Sabah • 1♂ 1♀; Ranau, Nunuk; 17 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—The titillators, cerci, and subgenital plate of our specimen resemble that of the type specimen (Ingrisch 1998). This species differs from its congeners by the straight apical margin of the male subgenital plate, cerci with dorsal carina ending in an acute angle, and apex of dorsal lobe triangular with apex rounded. This species is widespread in Mount Kinabalu National Park, described also from Sayap Substation (10 km north of Mount Kinabalu) and Poring (16 km east of Mount Kinabalu) (Cigliano et al. 2024).

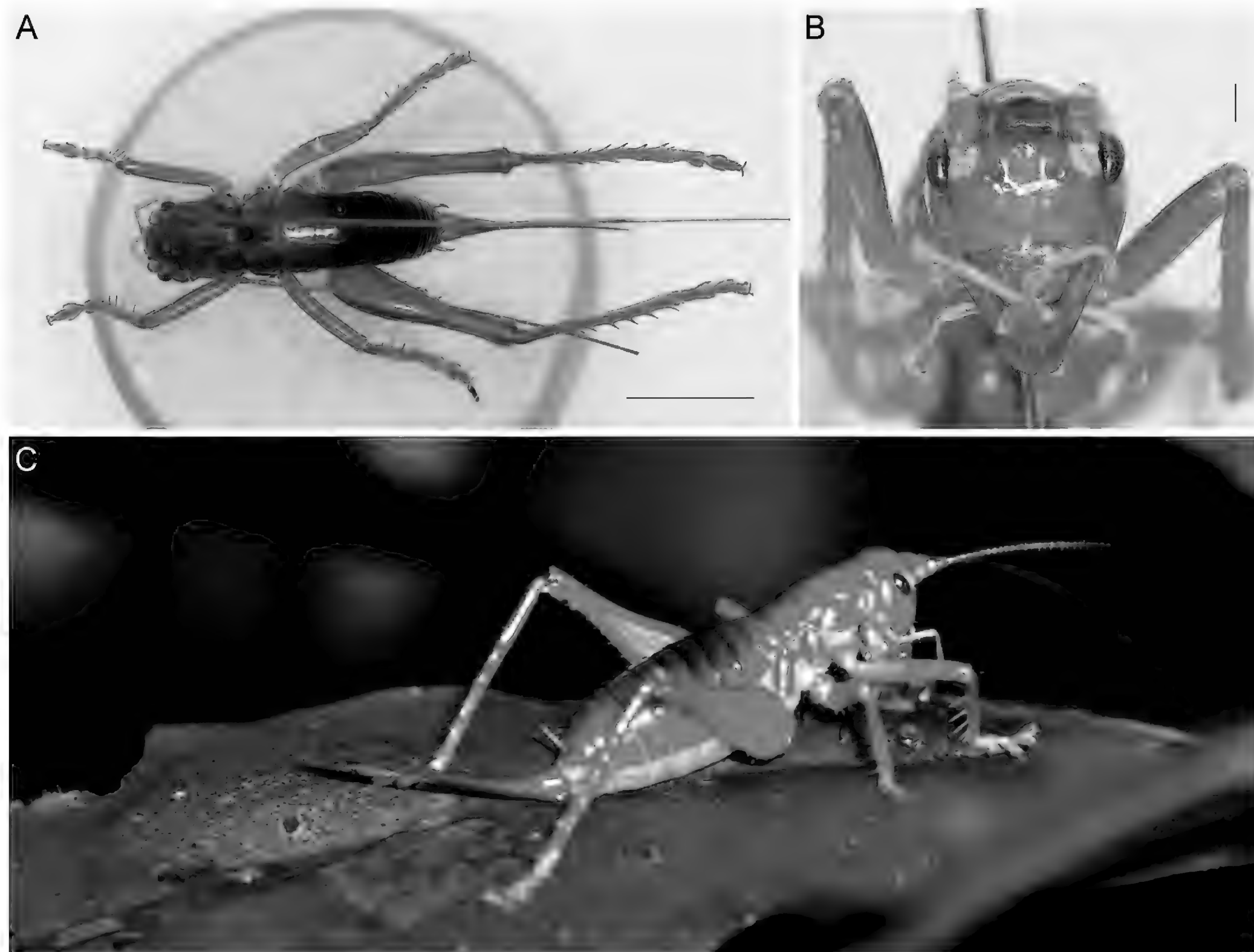


Fig. 19. *Monseremus appendiculatus*. A–C. Habitus in dorsal, frontal, and lateral view. Scale bars: 10 mm (A); 1 mm (C).

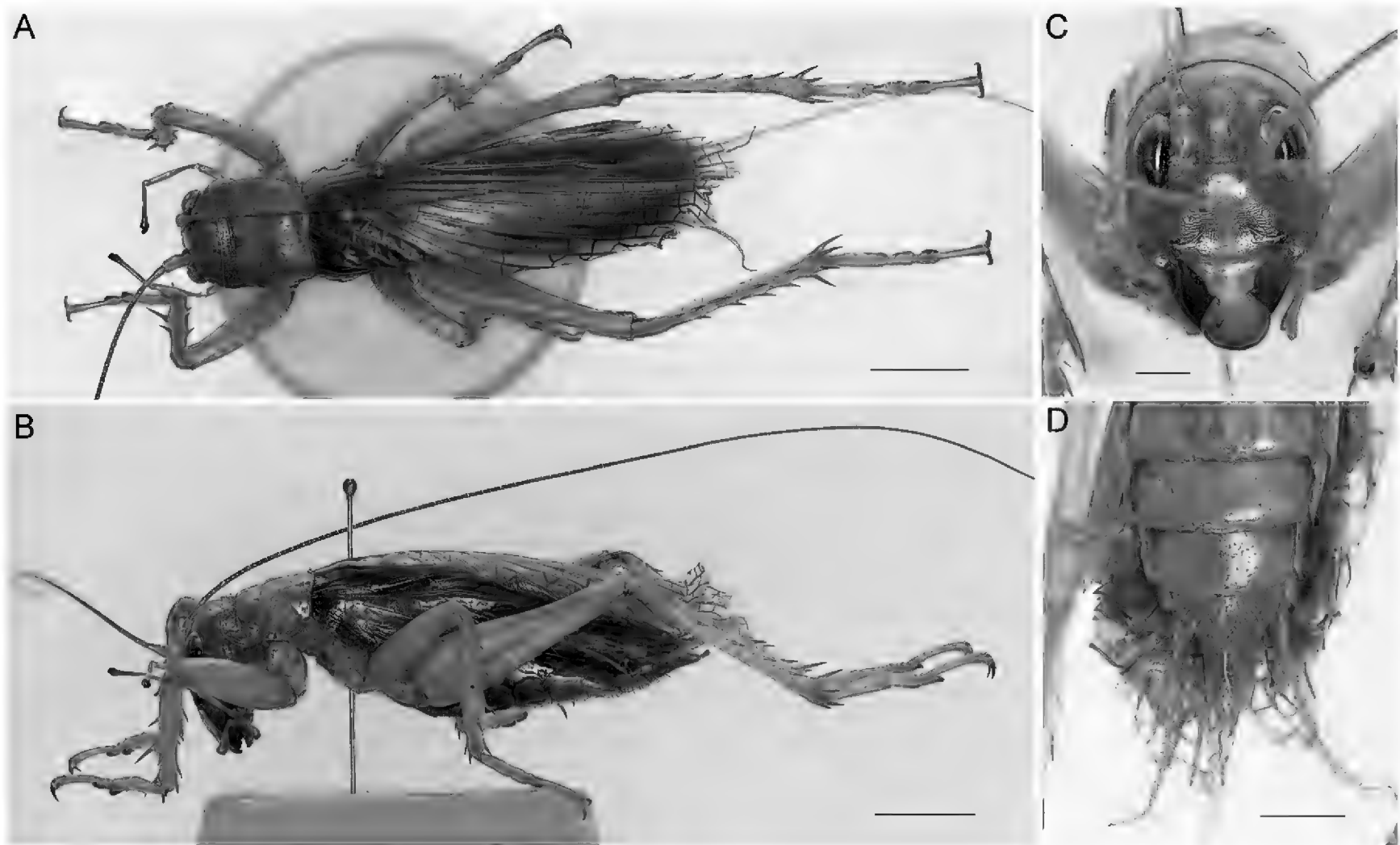


Fig. 20. *Sia bugajus*. A–C. Habitus in dorsal, lateral, and frontal view; D. Ventral view of male subgenital plate. Scale bars: 10 mm (A, B); 5 mm (C, D).

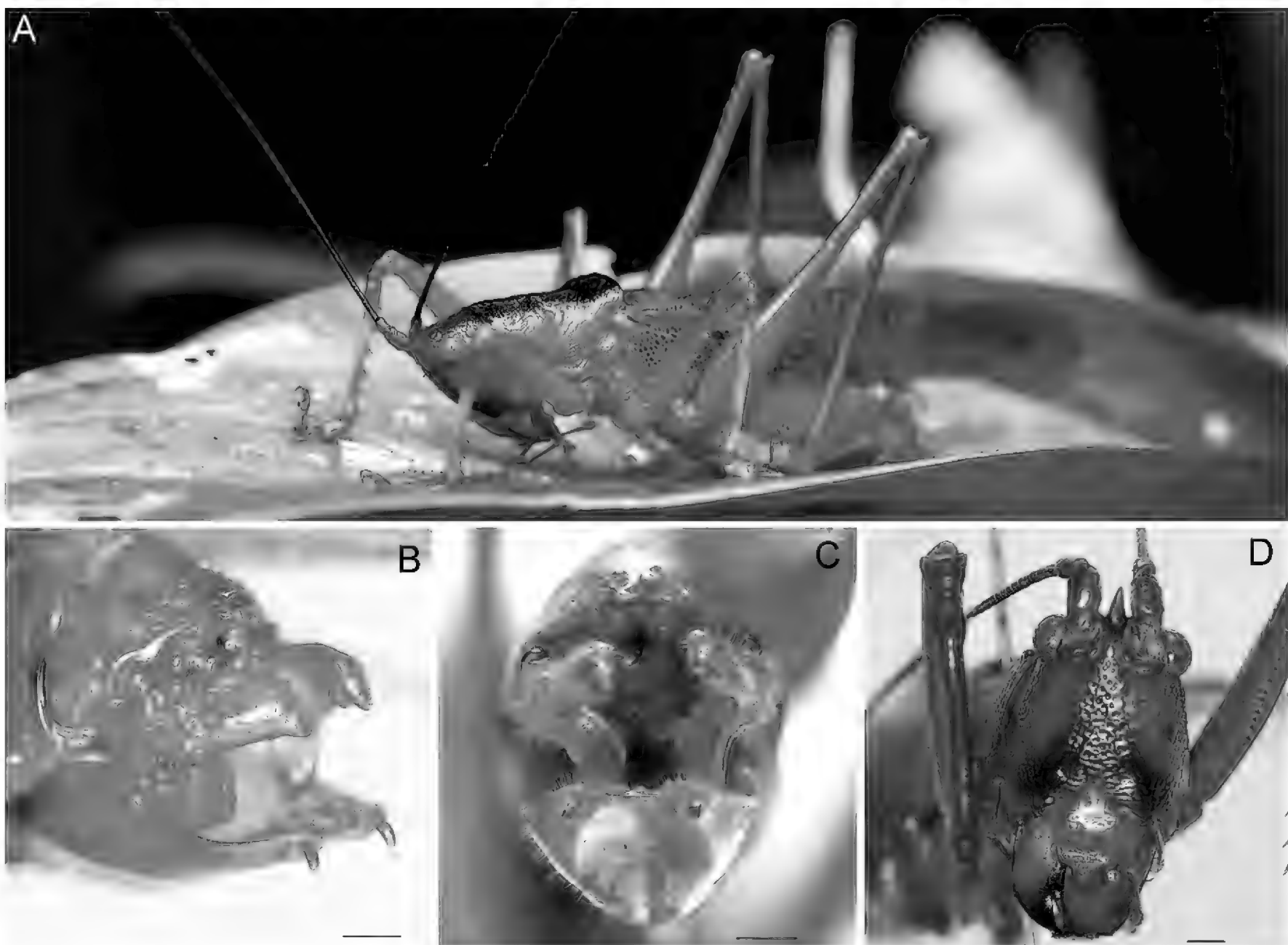


Fig. 21. *Eumacroxiphus* (*Eumacroxiphus*) *caudatus*. A, D. Habitus in lateral and frontal view; B, C. Male abdominal apex in postolateral and posterior view. Scale bars: 1 mm.

Subfamily Lipotactinae

Lipotactes sp.

Fig. 22

Material examined.—EAST MALAYSIA: Sabah • 1 nymph; Ranau, Nunuk; 17 October 2023; on foliage of understory plants; leg. A.A. Muhammad (photograph).

Remarks.—Only nymphs were spotted on the foliage of understory plants along the trail in the community forest area near Nunuk camp and only during the day. Identification used Gorochov (2021), but identification to species is impossible, as adult specimens are needed for comparison and cryptic species exist among these *Lipotactes* (Tan et al. 2020).

Fig. 22. *Lipotactes* sp.

Subfamily Meconematinae

Asiophlugis borneoensis Jin, 1993

Fig. 23

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 16 October 2023; on underside of foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was found during the night on the underside of the foliage of the understory plants at Nunuk camp. Individuals were found on separate leaves of the same plant or nearby ones. The specimen was compared with images in Gorochov and Tan (2011) and Kevan and Jin (1993). This species was first described from Bundu Tuhan, which is close to the sampling area.

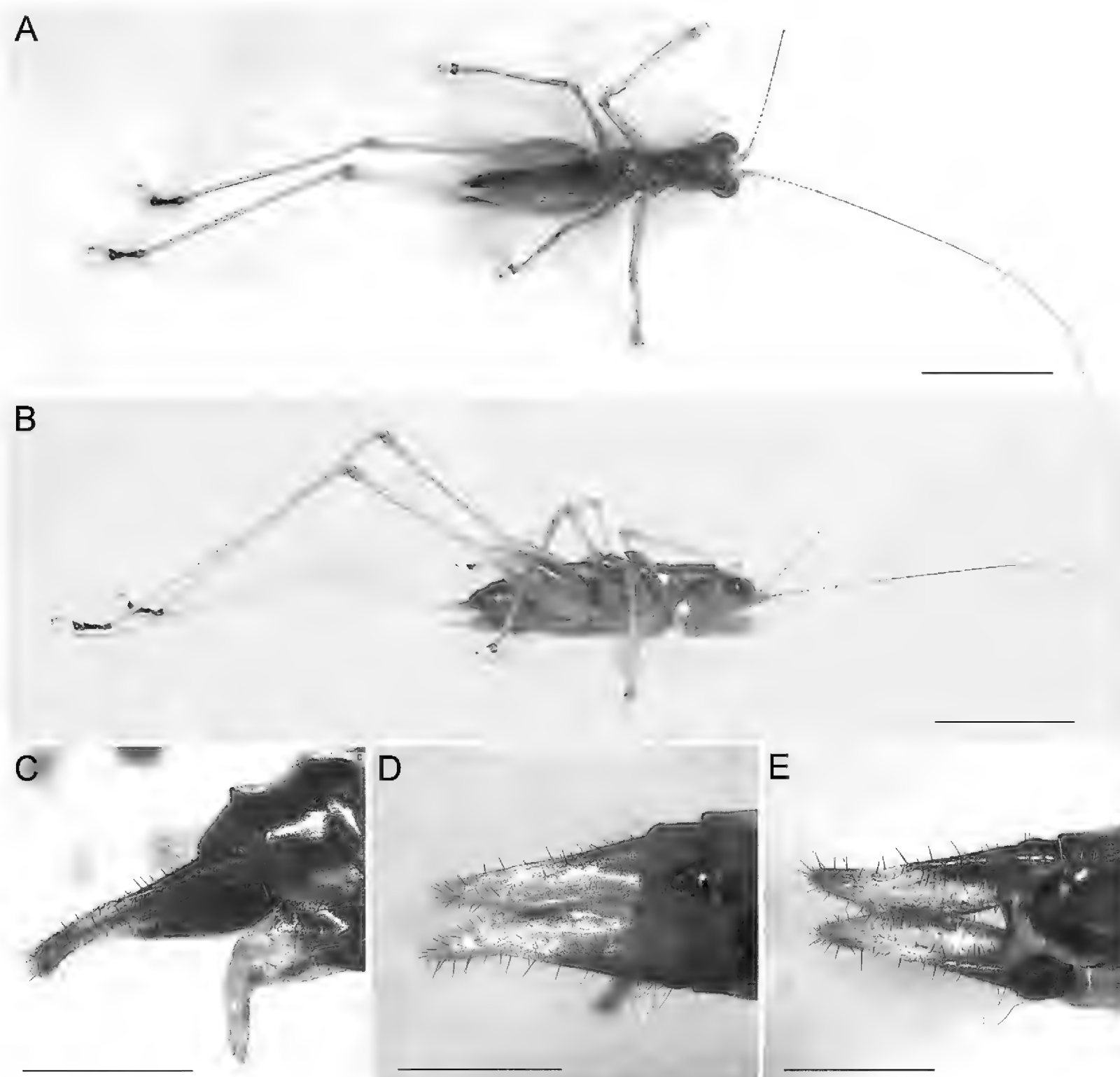


Fig. 23. *Asiophlugis borneoensis*. A, B. Habitus in dorsal and lateral view; C–E. Male abdominal apex in lateral, dorsal, and ventral view. Scale bars: 5 mm (A, B); 1 mm (C, D, E).

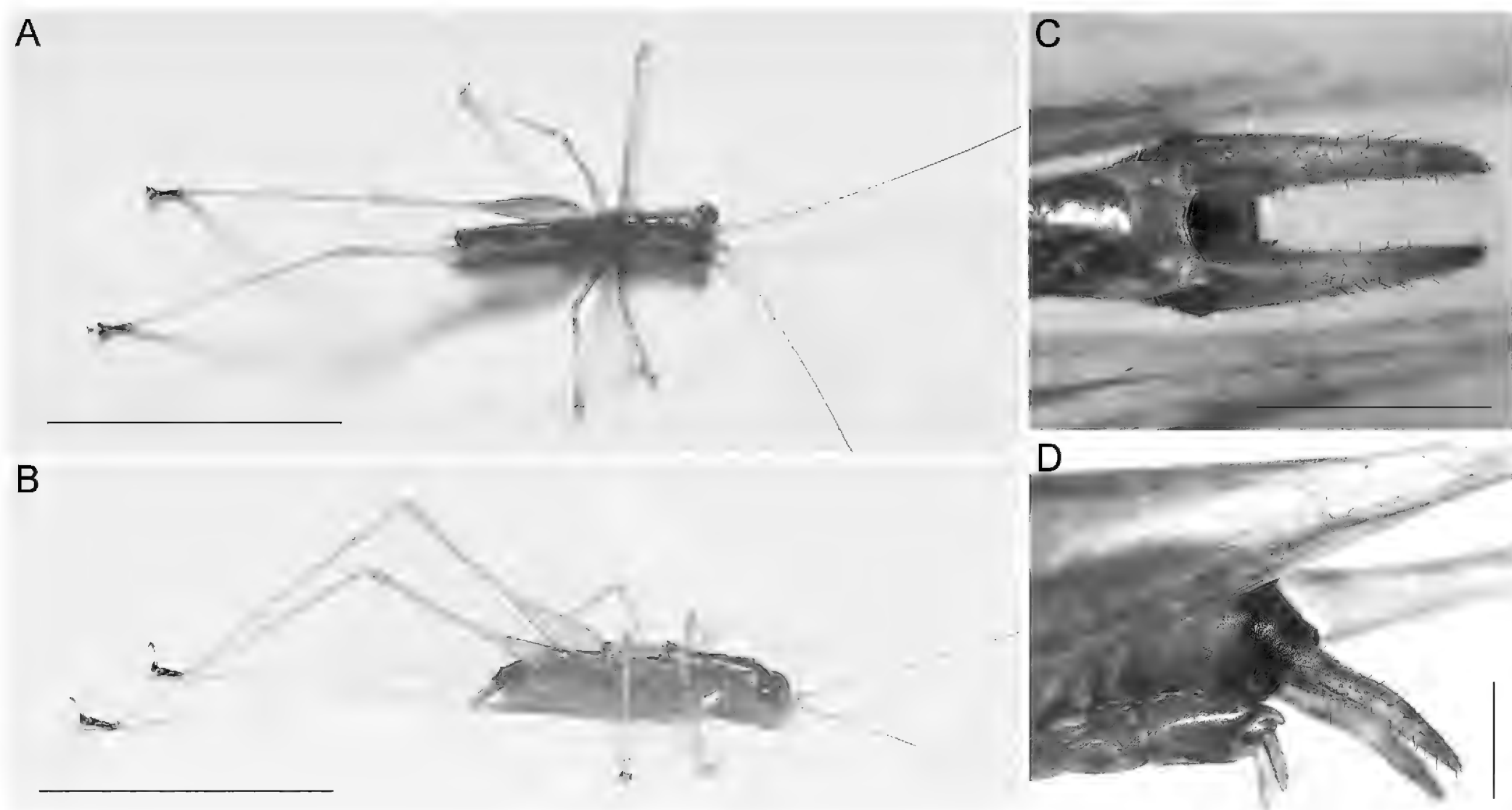


Fig. 24. *Asiophlugis* nr. *trusmadi*. A, B. Habitus in dorsal and lateral views respectively; C, D. Male abdominal apex in ventral and lateral view. Scale bars: 10 mm (A, B); 1 mm (C, D).

Asiophlugis nr. *trusmadi*
Fig. 24

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 16 October 2023; on underside of foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—Similar to *A. borneoensis* Jin, 1993, this species was found during nighttime on the underside of foliage of the understory plants at Nunuk camp. This species is similar to *A. trusmadi*, which has been described from Mt. Trus Madi [= Trusmadi], but differs slightly by the shape of the styli at the base of the subgenital plate. Our specimen may represent an undescribed species, but more specimens are needed for a better understanding of the intraspecific variation. The specimen was compared with images in Gorochov and Tan (2011). The type locality of *A. trusmadi* is Mount Trusmadi, which is situated 60 km south of Mount Kinabalu, Sabah.

Odonturisca dentata Gorochov, 2022
Fig. 25

Material examined.—EAST MALAYSIA: Sabah • 1♀; Ranau, Nunuk; 17 October 2023; at the wall of a building with a light source; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was attracted to a light source at a building at Nunuk camp. It differs from its congeners by the low and rounded humeral notches of the pronotum and the shape of the female subgenital plate and ovipositor (Gorochov 2022). The type specimen was also described from Mount Kinabalu National Park (Gorochov 2022).

Subtilodecma bilobata Gorochov, 2022
Fig. 26

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Kinabalu Park, Marai Parai; 14 October 2023; on underside of foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species was collected during the night on the underside of foliage of the understory plants at Nunuk camp. It can be found co-occurring with *Asiophlugis* species. There are

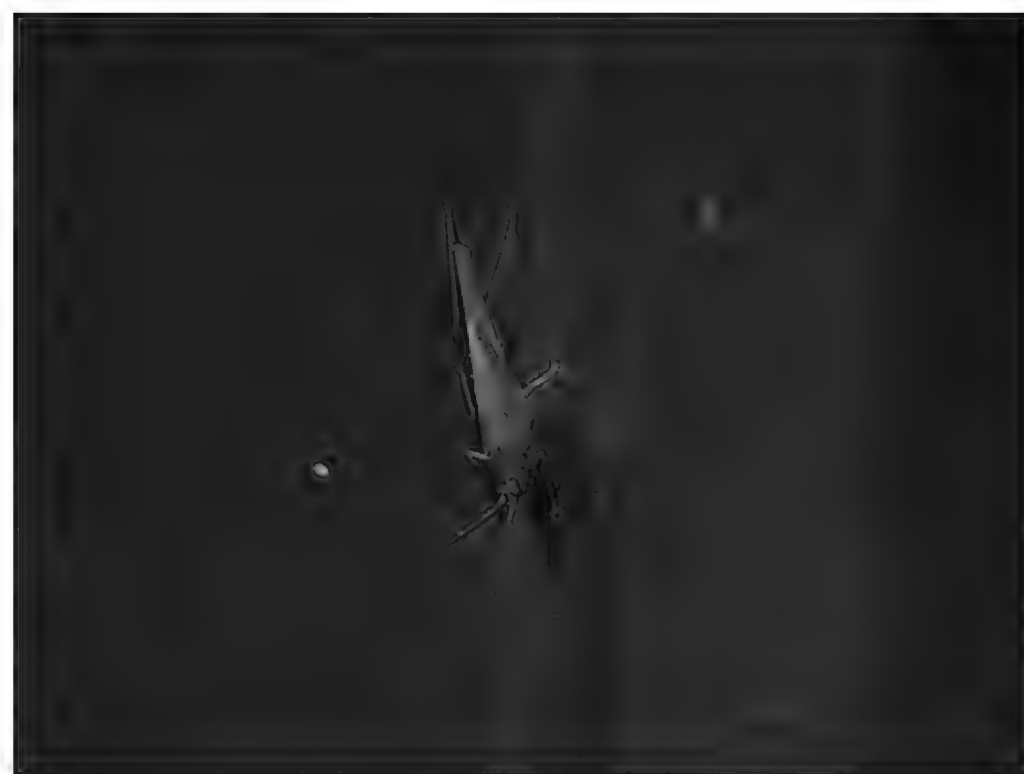


Fig. 25. *Odonturisca dentata*.

only two species in this genus, and both were recorded at Mount Kinabalu National Park (Gorochoy 2022), the other being *Subtilodecma unilobata* Gorochoy, 2022. This species differs from its congener by the male cerci being bilobate instead of unilobate apically, the distal portion of the male genital plate narrower, and the distal parts of the male tegmina somewhat shorter (Gorochoy 2022).

Subfamily Phaneropterinae

Mirollia (Hemimirollia) gracilis Karny, 1925

Fig. 27

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 17 October 2023; at the wall of a building with light source; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP • 1♂; Ranau, Nunuk; 17 October 2023; on foliage of understory plant; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This species is identified as *H. gracilis* based on the details of the male epiproct, cerci, and subgenital plate: male phallus without large sclerites, at most with small, semi-solid, in situ hidden structures, and the epiproct widening toward apex (Ingrisch 2011). The specimens were collected during nighttime, as they were attracted to a light source on a building at Nunuk camp and also on foliage of an understory plant. Apart from the type locality on Mount Dulit, Sarawak (Karny 1925a), this species has been recorded at Mount Trus Madi [=Trusmadi] (Gorochoy 2008b), Sorinsim (Gorochoy 2023b), and Kuala Belalong, Brunei Darussalam (Tan and Wahab 2018).

Sympaestria acutelobata Brunner von Wattenwyl, 1878

Fig. 28

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 17 October 2023; at the wall of a building with light source; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This specimen is identified as *S. acutelobata* based on the details of the stridulatory area (shape of the mirror on the right tegmen), although the male abdominal apex is similar (Tan 2014, Tan et al. 2019, 2024a). More material is needed to confirm the identification of this species from this region such that further taxonomic treatment of this genus can be done (Tan 2014, Tan et al. 2019). This species was collected during the night, as it was attracted to a light source on a building at Nunuk camp.

Tapiena sp.

Fig. 29

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Nunuk; 16 October 2023; on foliage of understory plants; leg. A.A. Muhammad, Supani T. & Jalter M.; EUSP.

Remarks.—This specimen is a member of the genus *Tapiena* Bolívar, 1906 having a rugose pronotum. The male abdominal apex closely resembles that of *T. incisa* Karny, 1923 and *T. bullata* Karny, 1923, but differs by the broad and flat unilobed cerci with serrate apical margin (distinctively bilobate apically with obtuse inner tooth in *T. incisa*), and subgenital plate with posterior margin more deeply excised in the middle (not excised in *T. bullata*) (Tan

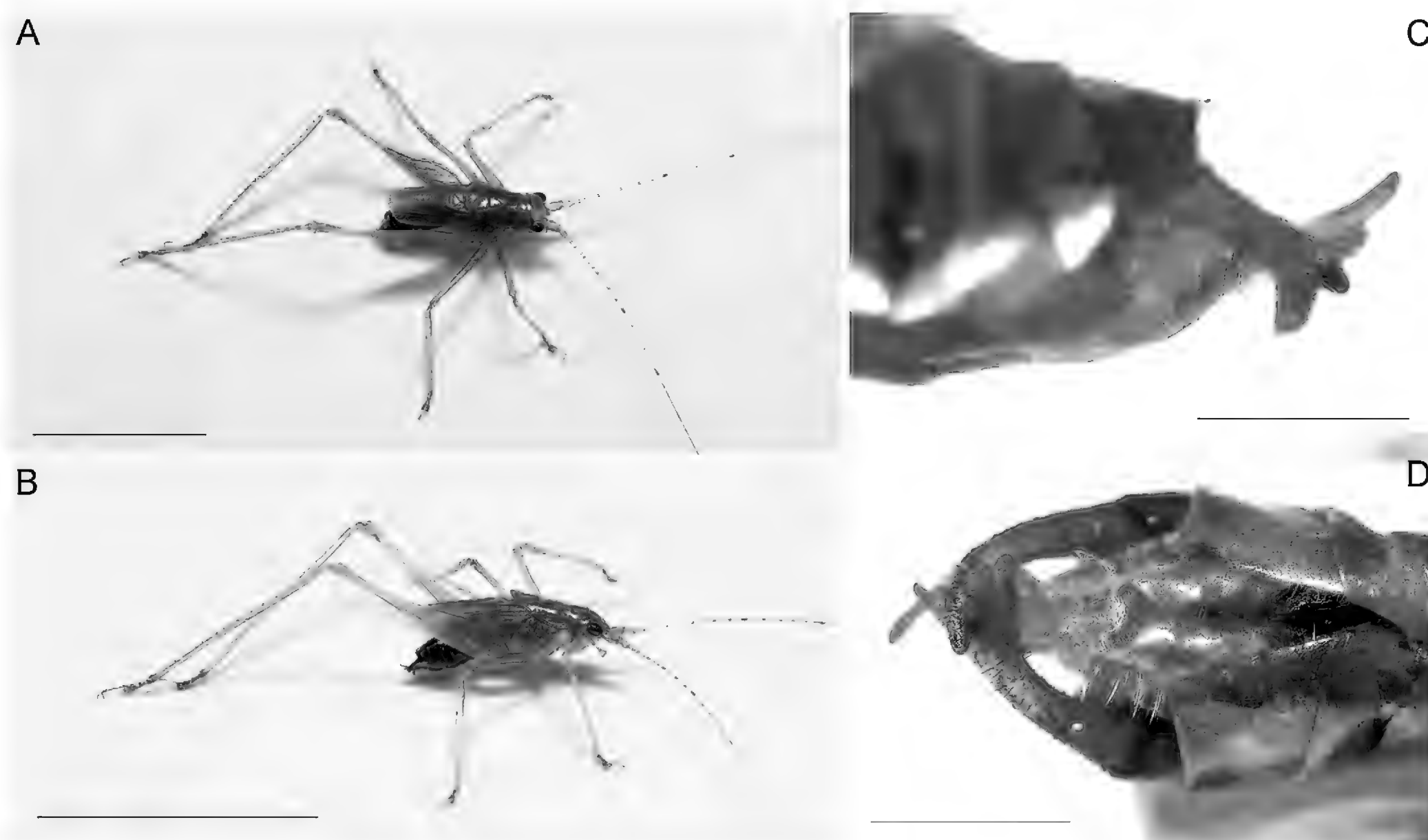


Fig. 26. *Subtilodecma bilobata*. A, B. Habitus in dorsal and lateral view; C, D. Male abdominal apex in lateral and ventral view. Scale bars: 10 mm (A, B); 0.5 mm (C, D).

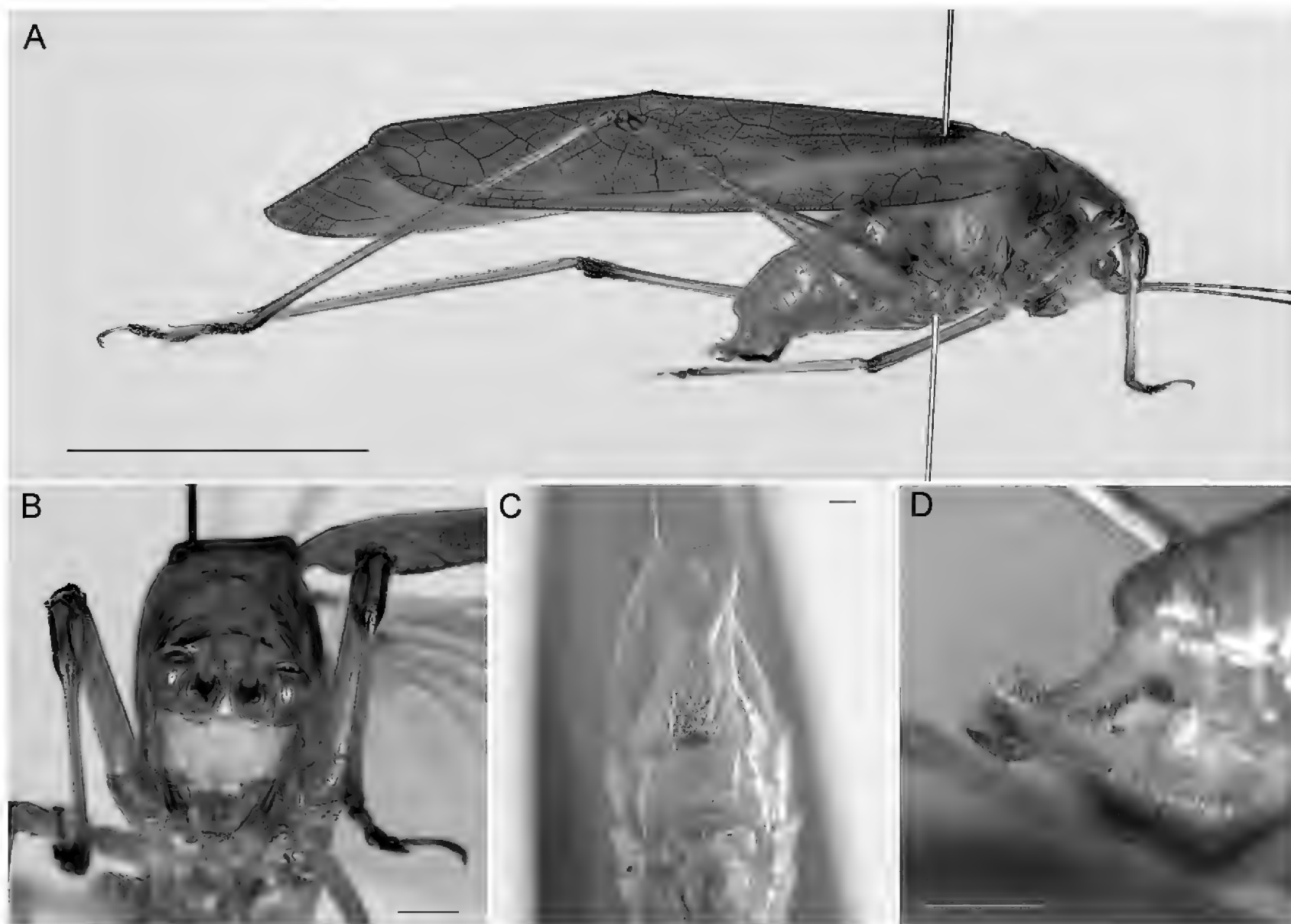


Fig. 27. *Mirollia (Hemimirollia) gracilis*. A, B. Habitus in lateral and frontal view; C, D. Male abdominal apex in ventral and lateral view. Scale bars: 10 mm (A); 1 mm (B, C, D).

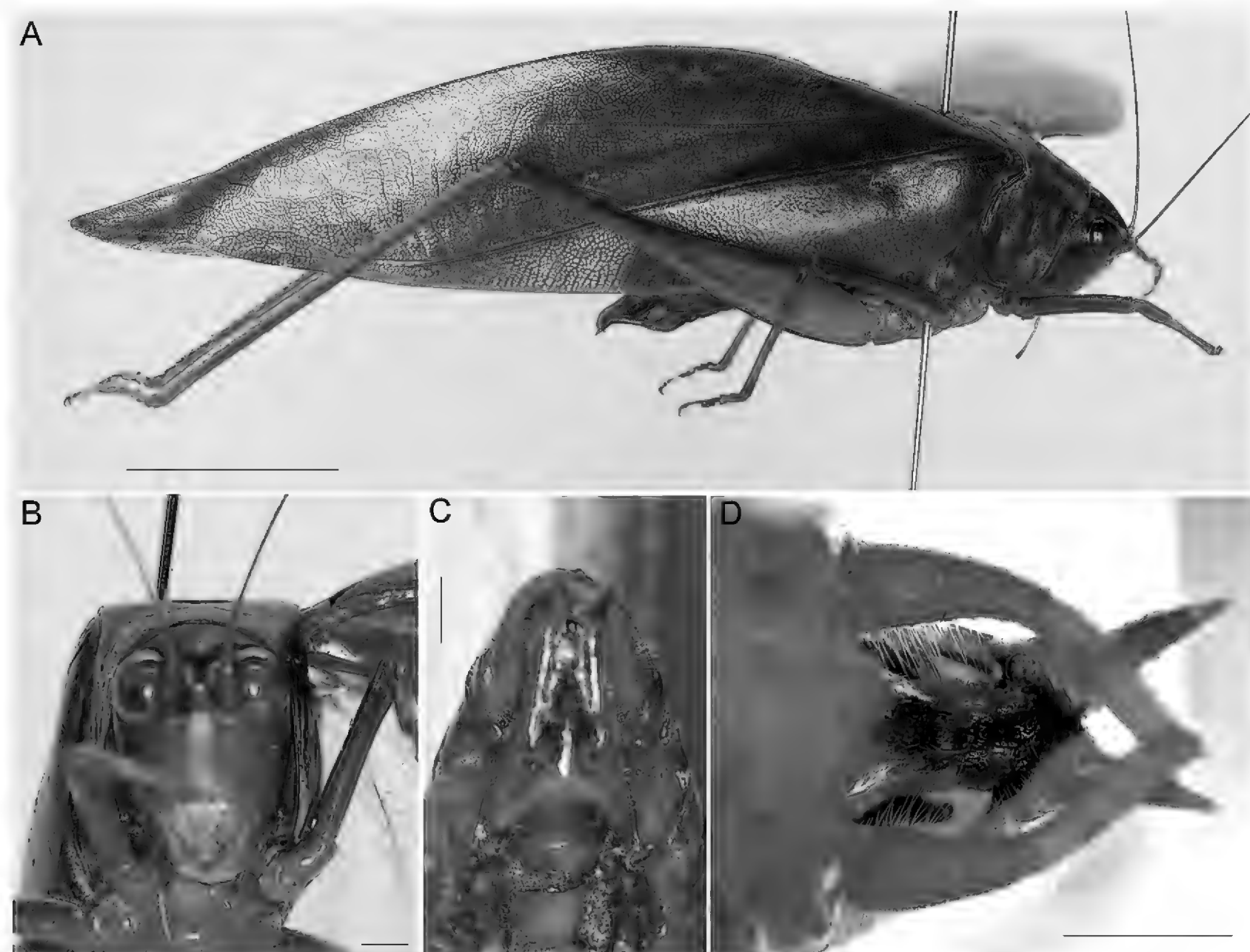


Fig. 28. *Sympaestria acutelobata*. A, B. Habitus in lateral and frontal view; C, D. Male abdominal apex in ventral and ventrolateral view. Scale bars: 10 mm (A); 1 mm (B, C, D).

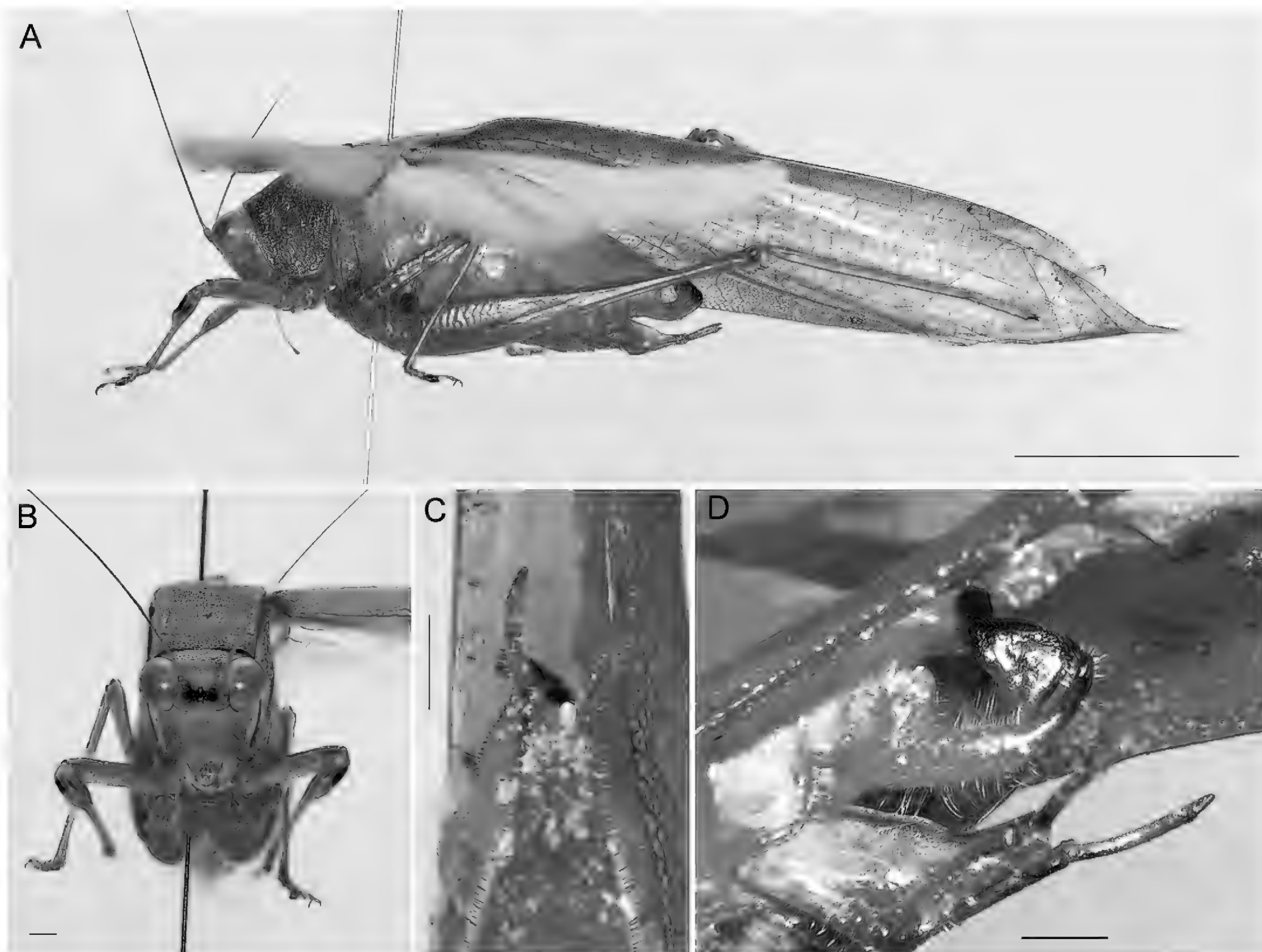


Fig. 29. *Tapiena* sp. A, B. Habitus in lateral and frontal view; C, D. Male abdominal apex in ventral and ventrolateral view. Scale bars: 10 mm (A); 1 mm (B, C, D).

et al. 2015). It appears most similar to *Tapiena ?incisa* (sensu Tan et al. 2024a) collected from Mount Trus Madi. More material is needed to confirm this species identification in this region. This species was collected during the night on the foliage of understory plants at Nunuk camp.

Subfamily Pseudophyllinae
Tribe Phyllomimini

Cratioma cf. *borneense*
Fig. 30

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Kinabalu Park, Marai Parai; 15 October 2023; on stem of a plant; leg. A.A. Muhammad, Supani T., Jalter M. & Frederick G.; EUSP.

Remarks.—Only two species of this genus were recorded in Sabah, with the other being *Cratioma oculatum* Karny, 1926. This species is similar to *C. borneense*, which has been described from Kina Balu [=Kinabalu] (Beier 1954), by the absence of a circular pattern on the tegmen and denser wing venation than in *C. oculatum* (Tan et al. 2019). The specimens were compared to images from OSF (Cigliano et al. 2024) for identification.

Despoina spinosa Brunner von Wattenwyl, 1895
Fig. 31

Material examined.—EAST MALAYSIA: Sabah • 1♂; Ranau, Kinabalu Park, Marai Parai; 14 October 2023; on stem of *Tetraria pili-sepala*; leg. A.A. Muhammad, Supani T., Jalter M. & Silver P.; EUSP.

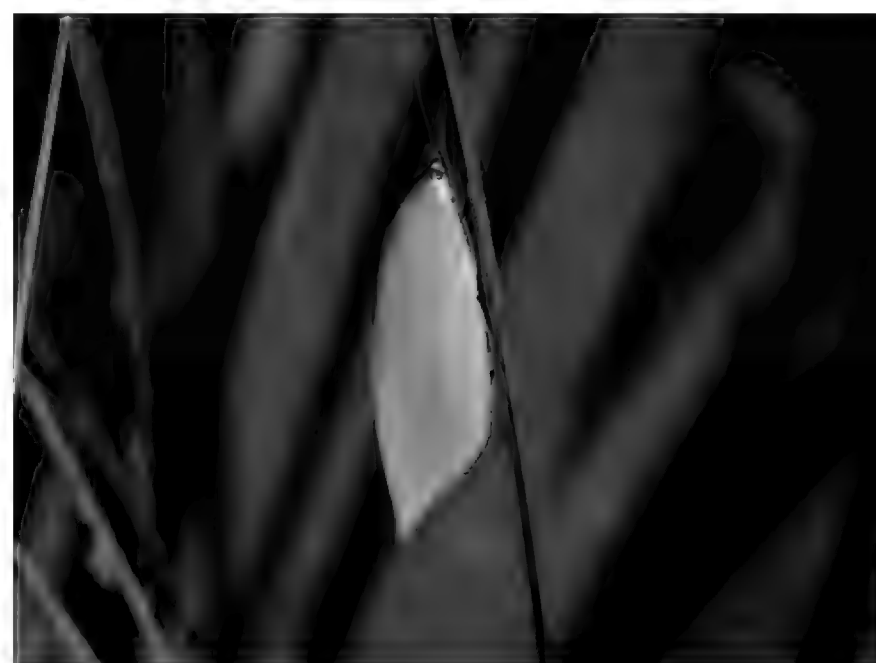


Fig. 30. *Cratioma* cf. *borneense*.

Remarks.—Only one male specimen was collected from a grassy patch at Marai Parai. This specimen is identified as *D. spinosa* based on spines on its pronotum, brownish-purple-dotted elytra, and the apex of its hind femora black. Beier (1954) assigned the type specimen collected from Kina-Balu [=Kinabalu] to *D. spinosa atrata* Beier, 1954, but subspecies identification is impossible due to a lack of material. Comparison with the type specimen of the other subspecies, *D. spinosa spinosa* Brunner von Wattenwyl, 1895 from Brunei, is also needed.

Promeca cf. *nobilis*

Fig. 32

Material examined.—EAST MALAYSIA: Sabah • 1♀; Ranau, Nunuk; 13 October 2023; on foliage of understory plants; leg. Paul Y.I. & Evan Q.S.H.; EUSP.

Remarks.—Only one female was collected during the expedition. This specimen closely resembles *P. nobilis*, but differs in having dark-colored sternites and the shape of the subgenital plate, possibly due to the artifact of preservation. The specimen was compared with type images from OSF (Cigliano et al. 2024). The type locality of this species is North Borneo (“Nord-Borneo, Waterstradt”), which refers to Sabah state, although the specific locality remains undetermined (Beier 1954, Liana 1999).

Discussion

The orthopteran diversity in and around Mount Kinabalu is not fully understood, although previous expeditions have been conducted there. Very recently, species and genera of katydids and crickets new to science were discovered. These include Holochlorini from Mount Trus Madi (Gorochoy 2023a, Tan et al.

2024a); Mirolliini katydids from Mount Trus Madi and Crocker Range (Gorochoy 2023b, Tan et al. 2024a); species of *Itara* and *Odontogrylloides* crickets and *Depressacca* katydids, each from Tenompok (Tan et al. 2024b, 2024c, 2024d); and *Pendleburyella* crickets from Mount Trus Madi and Bukit Hampuan (Tan et al. 2024e). This suggests that continued sampling in other less-explored regions of these vast mountain ranges is needed.

The call for further sampling is corroborated by the new locality records and potential new species found in the five-day sampling effort in Marai Parai and Nunuk presented here. Mount Kinabalu has several types of landscapes at various altitudes, which results in disparate vegetation (Kitayama 1992, Aiba and Kitayama 1999). The difference in habitat composition may influence the orthopteran species assemblages and spatial distribution (Joern 1982, Guido and Gianelle 2001, Ibanez et al. 2013), as reflected in this study in which only one overlapping species was present at both locations. Hence, habitat heterogeneity across this area signifies that more species are likely to be found, especially niche-specific species.

We also believe that many more undescribed species are still awaiting discovery in larger parts of the hyper-diverse Sabah and even Borneo. Mount Kinabalu region has historically been considered one of the more sampled regions in Sabah and Borneo (Tan et al. 2017). It is not a surprise, therefore, that we know even less about the orthopteran diversity in other parts of Sabah and Borneo. Beyond taxonomy, we also know little about the calling songs and natural history of orthopterans in this region (Tan et al. 2023), with most species described only based on morphology. Hence, there is a dearth of knowledge on orthopterans in this region, yet the biodiversity of Borneo is significantly impacted by the negative anthropogenic activities that threaten the existence of these orthopteran species (Miettinen et al. 2011, Ocampo-Peñuela et al. 2020).

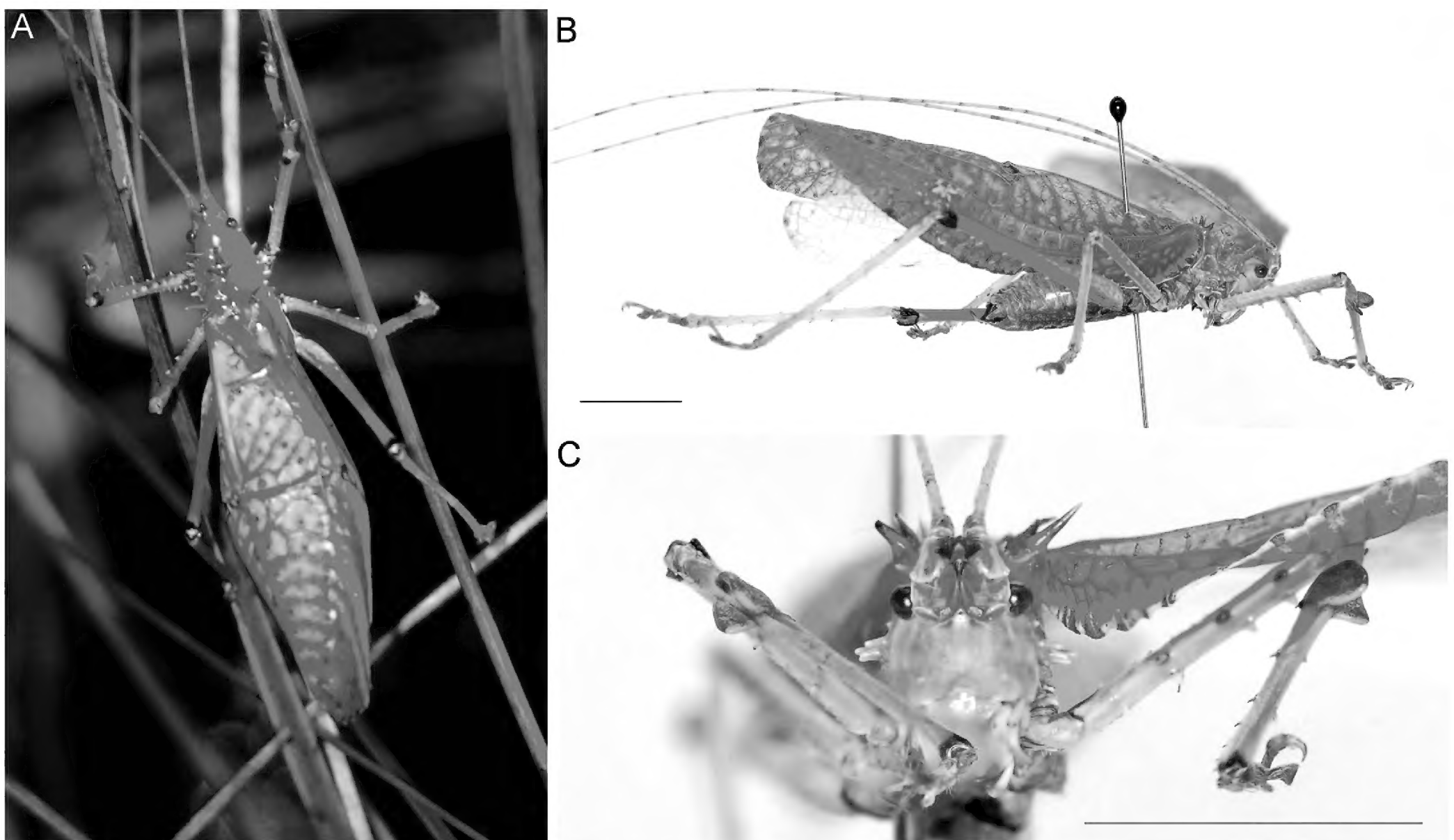


Fig. 31. *Despoina spinosa*. A–C. Habitus in dorsal, ventral, and lateral view. Scale bars: 10 mm.

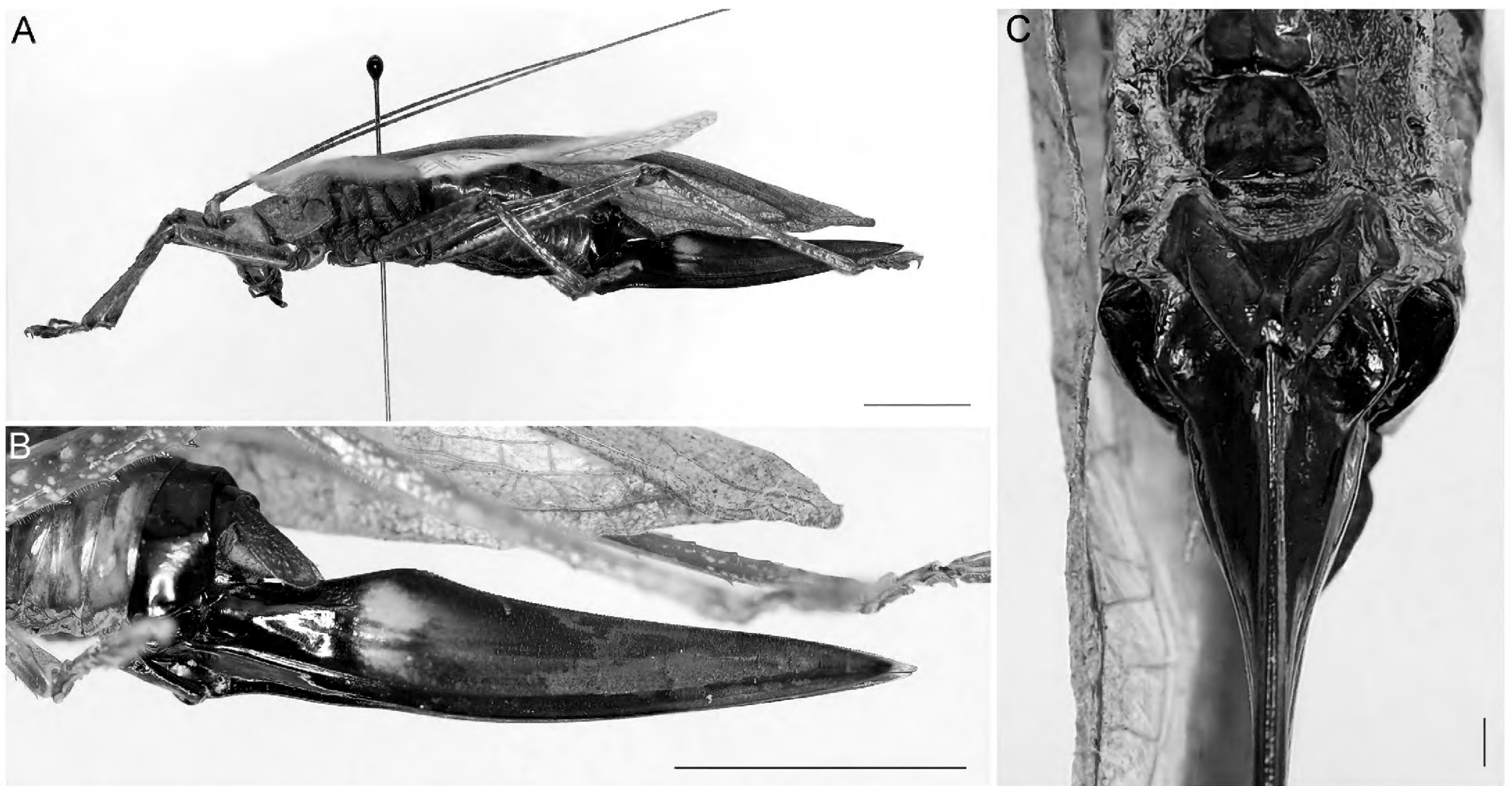


Fig. 32. *Promeca cf. nobilis*. A. Habitus in lateral view; B. Ovipositor in lateral view; C. Subgenital plate in ventral view. Scale bars: 10 mm (A, B); 1 mm (C).

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